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An Economic Assessment of Renovating Temporary Wood Frame Buildings

by
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Paul Armstrong

This research is intended to help installation Directorate of Engineering and Housing (DEH) personnel analyze the economic feasibility of renovating WWII era temporary wood frame buildings. A survey form and instruction guide were developed to collect information on the physical condition and structural soundness of these buildings. The form was used to evaluate WWII era buildings at four Army installations. Rehabilitation and maintenance cost data was collected at the four study sites. The major common problems of renovation and/or current use were identified. This research indicated that renovation of WWII buildings is an economic alternative to new construction.

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FOREWORD

This investigation was performed for the Master Planning Branch, Headquarters, Forces Command (HQFORSCOM). The Technical Monitor was Mr. James Carmody, FCEN-CDP-M. The U.S. Army Construction Engineering Research Laboratory (USA-CERL), under project number DACA 88-86-D-0001, "The Real Cost of WWII Wood Frame Buildings," engaged the services of the Department of Urban and Regional Planning at the University of Illinois at Urbana-Champaign. Department personnel directly involved in this research were: Peter V. Schaeffer, Assistant Professor of Planning; Paul Armstrong, Assistant Professor of Architecture; and Teresa Almeda, Man-Hyung Lee, and Paul Webber, Research Assistants.

The personnel from USA-CERL, Environmental Division (EN) involved in the study were John J. Fittipaldi, Principal Investigator, and Paul R. P. Skidmore, Research Assistant. Mr. Robert Neathammer of USA-CERL's Facility Systems Division reviewed preliminary drafts of this report. Dr. R. K. Jain is the Chief of USA-CERL-EN. The Technical Editor was Gloria J. Wienke, Information Management Office.

COL Carl O. Magnell is Commander and Director of USA-CERL, and Dr. L. R. Shaffer is Technical Director.

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AN ECONOMIC ASSESSMENT OF RENOVATING TEMPORARY WOOD FRAME BUILDINGS

1 INTRODUCTION

Background

The onset of World War II (WWII) required the rapid construction of wood frame buildings to satisfy the demand for barracks, administration buildings, maintenance buildings, and warehouses. These buildings were considered "temporary," to be disposed of after the war ended. However, many of these WWII wood structures are still being used today.

Congress has proposed that the Army remove the WWII era temporary wood frame buildings from its inventory as soon as possible unless their use is economically justified. A preliminary target date was set for 1990. Reasons cited for the removal include: energy inefficiency, operational inefficiency, costly maintenance, and limited fire safety.[1] However, Major General Norman G. Delbridge, Jr., Deputy Chief of Engineers said:

> The facility inventory of the Army, which includes WWII temporary buildings, is not adequate to support current and projected missions plus mobilization. The known construction requirement just to support rapid mobilization is $2.9 billion. A legislative requirement to tear down useful WWII facilities is unrealistic without replacement facilities and would be counterproductive and serve to increase the construction requirement needed for mobilization.[2]

In light of the Congressional proposal and the variety of policy attitudes toward the continued use of WWII temporary buildings, Headquarters, Forces Command (HQFORSCOM) asked the U.S. Army Construction Engineering Research Laboratory (USA-CERL) to assess the role of these buildings and answer the following questions. Do these WWII era buildings fulfill their current purposes adequately and economically? If not, can they be improved to perform satisfactorily at a reasonable cost?

This project is one of a series dealing with WWII temporary wood buildings (TWBs). One project being conducted concurrently provides guidelines for evaluating the use of these buildings.[3] Another project developed an easy-to-use computer program that provides an accurate method of estimating repair and remodeling costs.[4]

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[1] Military Construction Appropriations for 1985, Hearings Before a Subcommittee on Appropriations, House of Representatives, part 4, p 16, Tuesday, February 28, 1984.

[2] Major General Norman G. Delbridge, Jr., (Ret.) Military Construction Authorization and Appropriation, FY 1983, p 309.

[3] David Reed, et al., *Evaluation and Guidelines for the Use of Temporary Wood Buildings at U.S. Army Installations*, Technical Report N-88/06/ADA194989 (U.S. Army Construction Engineering Research Laboratory [USA-CERL], April 1988).

[4] Paul R. P. Skidmore and John J. Fittipaldi, *WWII Era Building Demolition and Renovation Cost Estimator (ESTER) 1.0 User's Manual*, Technical Report N-88/13 (USA-CERL, July 1988).

Objective

The objective of this research is to help Army installation Directorate of Engineering and Housing (DEH) personnel analyze the economic feasibility of retaining and upgrading WWII era buildings at U.S. Army installations. The following project goals were established to support the objective.

1. Develop and test a method to assess the physical condition and structural soundness of WWII wood frame buildings,

2. Collect and assess rehabilitation and maintenance cost data, and

3. Determine the major common problems of renovation and/or current uses.

Approach

A form to gather information on the physical condition and structural soundness of WWII wood frame buildings was developed. To ensure consistency in its use, a short instruction guide was also written. (The form and guide are in Appendix A.)

The initial survey evaluated 28 buildings at 3 Army installations: Fort Lewis, WA; Fort Ord, CA; and Fort Hood, TX. Each installation has a large inventory of WWII era buildings. These three study sites were selected because they represent a range of environmental conditions and differing management and maintenance practices. The buildings were selected in collaboration with installation personnel to ensure representation of the three major uses (barracks, administration, and warehousing/storage) and of building conditions. A random sample process was not feasible due to uncertainty about access to some buildings at the time of the site visits.

The initial evaluations took place during July and August 1986 and were successful in obtaining information about the structural condition of WWII era wood frame buildings. However, the approaches to dealing with these buildings were sufficiently different among the three bases to warrant a visit to another site. Fort McCoy, WI was chosen because almost all its buildings are WWII era wood frame structures and the installation is located in yet another climatic region. Fort McCoy also differs from the other installations in that it does not serve regular Army units but the National Guard and Army Reserves. The evaluation of 20 buildings at Fort McCoy took place during January 1987. Figure 1 shows the general location of the four installations.

The information obtained by inspecting these TWBs was verified and supplemented through interviews with DEH personnel. Additional information on maintenance procedures, recurring maintenance problems, rehabilitation costs, and operating and maintenance costs was requested.

The costs of alternatives were evaluated using economic analysis. Present values of investment alternatives were calculated to provide a basis for comparison.

Scope

The scope of this study precluded an investigation of all possible uses of WWII wood frame buildings. Three major uses were selected for investigation: barracks, administration buildings, and warehouses. However, most of the findings can be generalized to other uses as well.

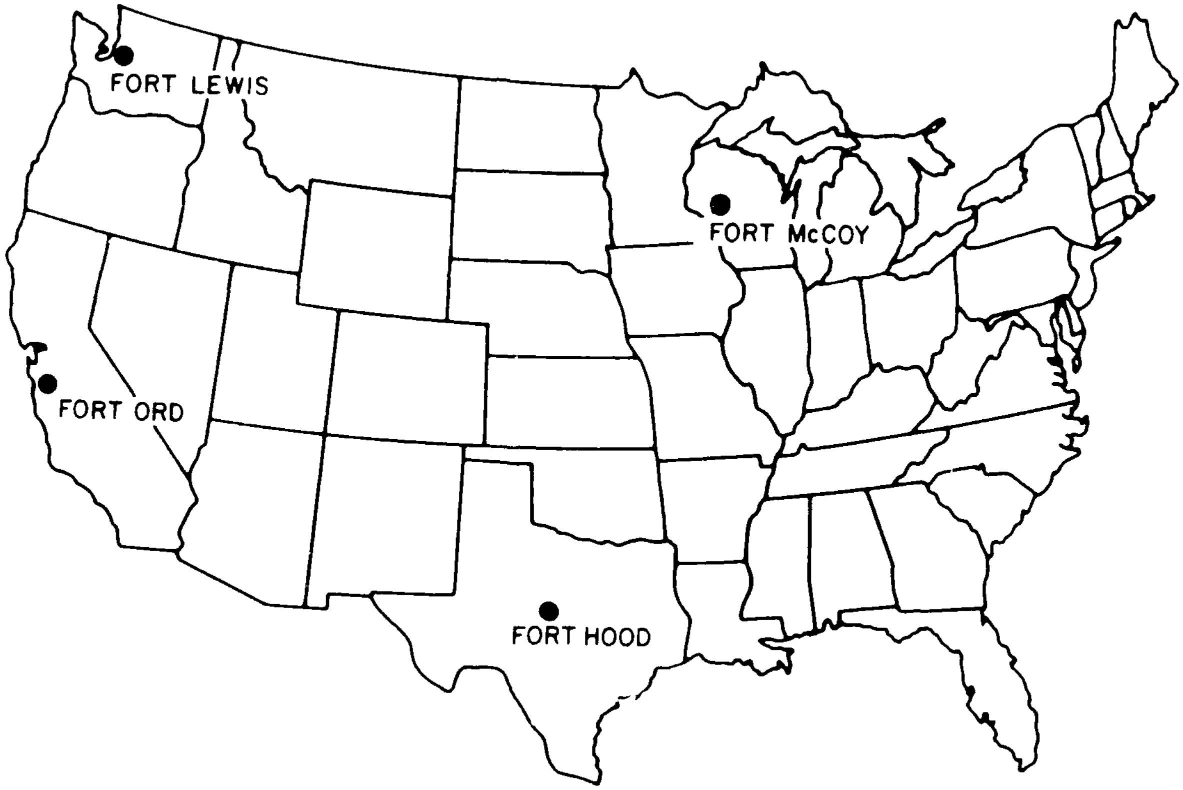


Figure 1. Location of study sites.

2 DESCRIPTION OF STUDY SITES

Climatic and Environmental Conditions

Appendix B contains weather data for each study site. The data indicate that the weather at the study sites is not a major threat to wood structures. Preventive maintenance procedures should be sufficient to reduce major problems due to the climate. However, the weather at any site must be independently evaluated to determine how it affects the building's condition and maintenance and repair efforts.

To assess the probability of a building decaying because of the climate, even when similar maintenance procedures are followed, R. C. DeGroot developed a climate decay index for the United States.[5] According to DeGroot, three of the four study sites are located in regions where the climate decay index is in the medium range. Only Fort Ord is in a region with a low decay index.

Termite infestation poses another threat to wood structures. Forts Ord and Hood are located in regions where the probability of subterranean termite infestation is high and Forts Lewis and McCoy are located in regions where the probability is slight to moderate.[6]

The possibility of an earthquake reducing a structurally sound building to a pile of rubble must also be considered. The effect of an earthquake ranges from no damage (Fort Hood), to minor damage (Fort McCoy), to major damage (Fort Lewis), and disaster (Fort Ord). However, WWII era temporary wood frame buildings generally suffer less damage than permanent construction.

Inventory of WWII Era Buildings

All four installations have a large number of WWII era wood frame buildings which were constructed between 1940 and 1946. Table 1 presents the current uses of the buildings by major use categories. (The information for Fort McCoy was not available, except for the total number of wood frame buildings, and for the percentage that are barracks.) It is immediately apparent that these buildings play only a small role in housing enlisted men at Forts Hood and Ord. At Fort Hood, permanent troops are no longer housed in temporary wood frame barracks. At Fort Ord, the same situation is anticipated by about 1990. By contrast, 315 WWII era barracks house permanent troops at Fort Lewis.

Description of WWII Era Buildings

In most cases, WWII wood frame buildings are overengineered. They have wood pile foundations supported by concrete spread footings and contain large quantities of clear, full dimension wood that is tightgrained and knot free, indicating that only heartwood

[5] R. C. DeGroot, "An Assessment of Climate Index in Predicting Wood Decay in Houses," *Durability of Building Materials* 1 (1982), pp 169-174.

[6] R. H. Beal, J. K. Mauldin, and S. C. Jones, "Subterranean Termites - Their Prevention and Control in Buildings," *Home and Garden Bulletin 64* (U.S. Department of Agriculture, Forest Service, 1983).

Table 1

Current Use of WWII Era Wood Frame Buildings

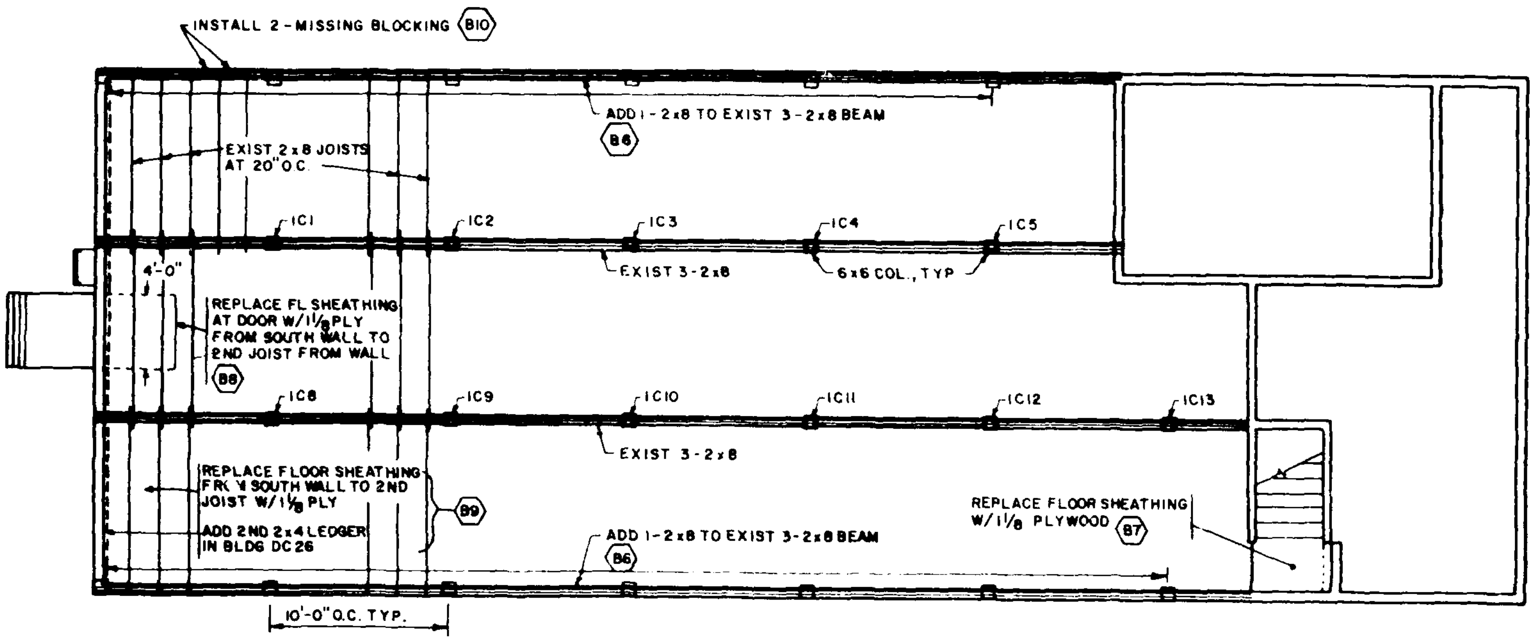
Use	**Fort Lewis**		**Fort Hood**		**Fort Ord**		**Fort McCoy***	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Enlist. Barracks	315	22.2	31	4.2	145	14.3		30.0
Admin & Supply	168	11.9	27	3.6	1	0.1		
General Storehouse	156	11.0	44	5.9	136	13.4		
Admin - General	104	7.3	83	11.2	144	14.2		
Detached Day Room	101	7.1	2	0.3	26	2.6		
General Instruction	83	5.9	36	4.9	29	2.9		
Enlist. Personnel Dining	81	5.7	1	0.1	19	1.9		
General Purpose Storage Shed	52	3.7	51	6.9	22	2.2		
Vehicle Maintenance Shop	50	3.5	94	12.7	21	2.1		
Army Res.Center Bldg.	32	2.3	0	0	0	0		
Company Headquarters	18	1.3	4	0.5	60	5.9		
Battalion HQs	15	1.1	33	4.5	29	2.9		
Gen. Operations Bldg.	0	0	30	4.0	46	4.5		
Batt.Con.Arms Stor.	5	0.4	58	7.8	9	0.9		
Guest House	1	0.1	4	0.5	41	4.0		
Other	236	16.7	243	32.8	285	28.1		
Total	1417	100.0	741	100.0	1013	100.0	1566	30.0

*Other information not available.

was used. Structural trusses and chords are often doubled. Columns are oversized for design loads and extra crossbracing is added to prevent racking and twisting. Floor joists are substantial (typically 12 in. deep for a two-story barracks) and closely spaced. Large, clear wood beams distribute the building's weight to a grid of piers aligned 10 ft on center.

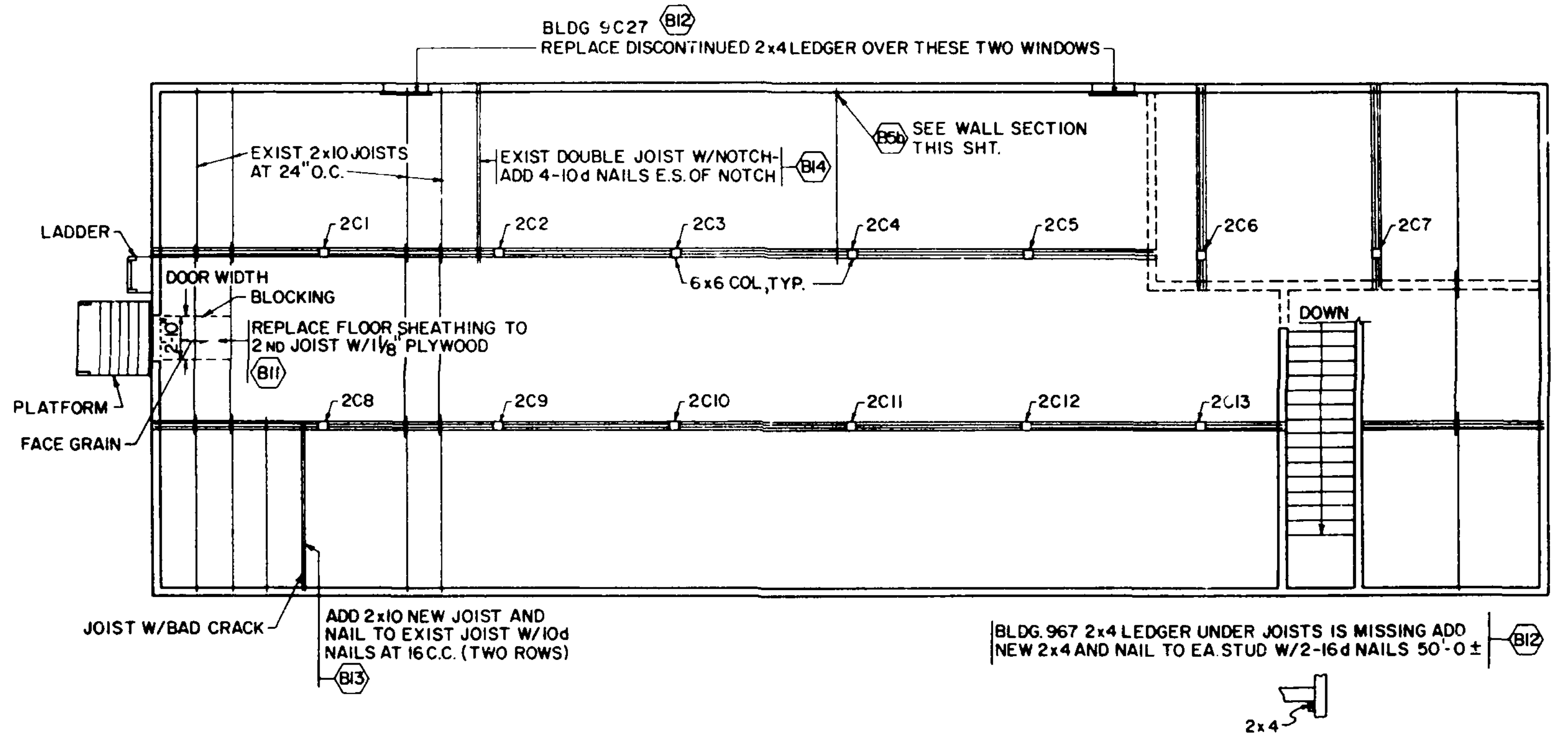
Barracks

The hallmark of WWII era buildings is their inherent simplicity and adaptability. A barracks prototype was quickly developed and was only slightly modified at different installations (see Figure 2 for floor plans). For instance, the mechanical room of barracks at Fort Lewis (containing an oil furnace, water heater, and electrical switchbox) was located on a slab-on-grade. An exterior duct vented the furnace in the mechanical room to a freestanding chimney approximately 8 ft from the building. A brick base rising 10 to 15 ft from the ground supported a metal flue which was tied into the roof by metal bracing (Figure 3). Mechanical rooms at Fort Ord were in the center of the building and were raised on piles to be even with the first floor (Figure 4). The freestanding chimneys were eliminated. Although the latrines were typically located at one end of the barracks on a slab-on-grade foundation, some latrines at Fort Lewis had been housed in separate one-story slab-on-grade buildings located near the barracks.



FIRST FLOOR PLAN – BARRACKS (TYPES 1,2,3,4,&5)

Figure 2. Barracks Floor Plans.



SECOND FLOOR PLAN - BARRACKS (TYPES 1,2,3,4, & 5)

Figure 2. (Cont'd)

Figure 3. Free-standing chimney of a barracks at Fort Lewis.

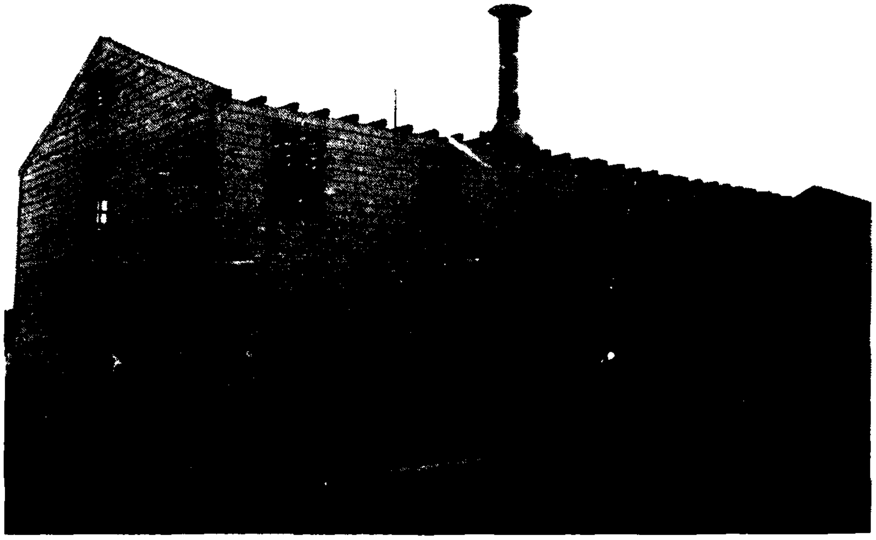


Figure 4. A barracks (being demolished) at Fort Hood with the chimney incorporated into the building.

The original interiors of WWII era barracks were open and unobstructed. Column grids modulated spans and distributed loads evenly to supporting piers (Figure 5). First and second floor plans were very similar. Ductwork was located along the longitudinal axis of the building. Interior wall surfaces were left unfinished with exposed studs and exterior sheathing. Wood double-hung windows were standard. Interior partition walls were originally clad with boards. Electrical wiring was usually exposed.

Dining Halls

Dining halls have a more specialized function. In plan, dining halls at all installations were uniform. All the buildings were one-story and raised on wood-pile foundations. A large open room, about two-thirds of the total building area, was dedicated to troop dining. The remaining area housed the kitchen facilities, including all food preparation and food storage equipment, plumbing, ventilation, electrical circuit box, water heater, and dishwasher. In most cases this room was partitioned, thereby creating a small room in one corner. In several instances, this partition was removed to create more space for the kitchen equipment. A space heater in the dining room provided heat during cold weather. Typically, an overhang or covered passageway sheltered the entrance. Health regulations require screens on all dining hall windows and doors. Behind the building, directly outside the kitchen, was a concrete pad which served as a loading area for supplies and services (Figure 6). Because storage space was sometimes insufficient, sheds were placed in this area.

Previous Renovations of Barracks

In the 1960's, the Army made an effort to renovate WWII wood buildings. Priority was given to troop barracks, dining halls, and administration buildings in that order. These renovations have been generically labeled "Bruckerization" in deference to the general who issued the mandate to update the buildings, making them more inhabitable and functional.

The typical Bruckerized barracks at the survey sites had been partitioned into two-man rooms. Interior partition walls were constructed of 2 by 2 studs covered by 1/8-in. wallboard on each side. New electrical wiring and new light fixtures were installed. Exterior walls were insulated and covered with wallboard, new vinyl asbestos tile (VAT) flooring was laid, and finished ceilings were installed. Latrines were remodeled and in some cases were added to the second floors of some troop barracks. New lavatory and toilet fixtures were installed where necessary, exposed plumbing was repaired or renewed, and new concrete floor topping or terazzo tile was installed. Enameled steel or water resistant wallboard was added to interior latrine walls. Operable windows in the showers were replaced with fixed windows and a single exhaust fan was added. In many barracks, the fan's capacity has proved insufficient to remove moisture buildup resulting in problems of peeling paint and decay. The shower walls were clad with ceramic tile and metal shower pans were installed to protect the wood structural members and subflooring. Failure to properly install shower pans at Fort Ord resulted in wood rot, mold, and decay in many troop barracks.

"Volarization" was a program instituted during the 1970's to renovate WWII era buildings. (The term refers to the all-volunteer Army.) Volarization was intended to be an economical solution for updating troop barracks using inexpensive materials and labor.

Figure 5. Open interior of a WWII era temporary barracks.

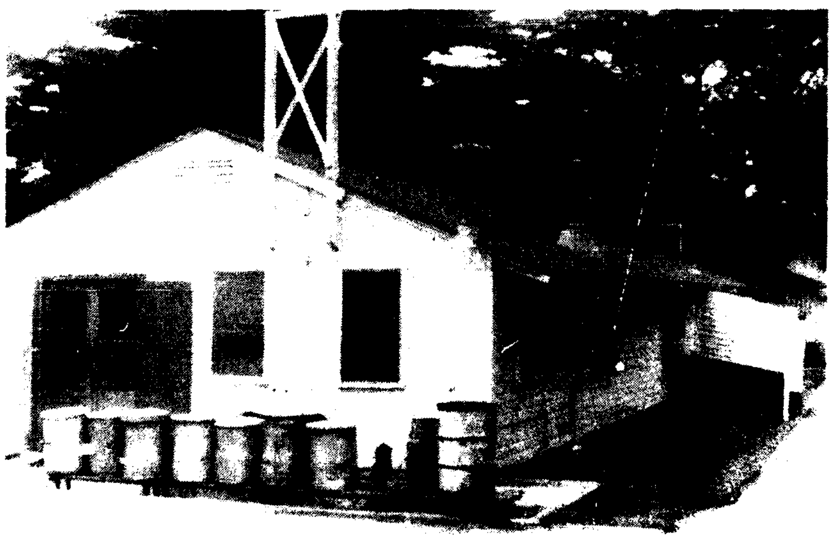


Figure 6. Dining hall for enlisted personnel.

Most of the renovations under these two programs were accomplished by troop labor rather than outside contractors. The decision to substitute inexpensive materials in order to rehabilitate the largest number of buildings for the dollar fell short of providing longer term solutions toward upgrading troop barracks and making them relatively easy to maintain and able to withstand the normal day-to-day use. The Volarized buildings, in particular, were characterized by cheapness. The materials have not performed well over time and are easily damaged through normal use.

3 SURVEY RESULTS

The evaluation form (Appendix A) used for inspecting the TWBs is organized by major building components: structure, exterior siding, exterior finishes, exterior windows and doors, plumbing, HVAC, and electrical. Components are rated poor, average, or good. A good rating was given only to components that performed as well as equivalent new components. An average rating meant that the component performed its functions satisfactorily, while a poor rating indicated deficiencies.

During the visits to Forts Lewis, Hood, and Ord, 28 buildings were carefully inspected. Twenty buildings were inspected at Fort McCoy. The buildings were selected by the DEH to represent a variety of uses. Table 2 presents a summary of these buildings by use categories.

Recent Building Renovations

Each survey installation has prioritized its own needs regarding WWII wood building rehabilitation/renovation. Figures 7 through 10 show improvements made at each of the four survey installations.

Extensive rehabilitation of WWII TWBs has been undertaken at Fort Lewis. New interior partition walls were installed using 2 by 4 wood studs covered with either gypsum drywall or 1/8-in. wood panel wallboard. New electrical wiring and new light fixtures were installed. New VAT floor covering and finished ceilings (drywall or acoustical tile) were added. All exterior walls and attic spaces were insulated. Decayed or damaged building components were replaced as required. In the latrines, new watertight cement topping was laid, new lavatory and toilet fixtures installed (when required), wall-hung lavatory mountings were reinforced, and exposed plumbing was replaced as necessary.

Table 2

Survey Sample TWBs by Current Use

Current Use	Fort Lewis	Fort Hood	Fort Ord	Fort McCoy
General Storage	1	2	2	
Administration	1	3	2	9
Enlisted Barracks	6		3	7
General Instruction	1			1
Detached Day Center	1			
Mess Hall	2		2	3
Unknown	1		1	
Total	13	5	10	20
One-story	6	3	6	7
Two-story	7	2	4	13

WW II TEMPORARY WOOD STRUCTURE REHABILITATION — FORT LEWIS

	ROOF	EXTERIOR SIDING	WOOD	CEMENT ASBESTOS	METAL/VINYL	WINDOWS	WOOD	ALUMINUM	OTHER	FLOORING	VINYL	CARPET	OTHER	WALL COVERING	GYPSUM DRYWALL	WALL BOARD/PANEL	CERAMIC TILE	PARTITIONS	CEILINGS	ACOUSTICAL TILE	OTHER	PLUMBING	WATER HEATERS	FIXTURES	HVAC UNIT	DUCTWORK	ELECTRICAL	WIRING	LIGHTING
TROOP BARRACKS																													
"BRUCKERIZATION"				●							●		●			●		●	●		●			●				●	●
"VOLARIZATION"				●							●		●			●		●			●			●				●	●
OTHER	●				●			●			●	●			●	●	●			●	●							●	●
DINING HALLS	●			●			●				●		●		●	●				●								●	●
ADMINISTRATION	●				●			●			●	●			●	●		●		●				●				●	●
WAREHOUSES	●			●																								●	●

Figure 7. Building rehabilitation at Fort Lewis.

WW II TEMPORARY WOOD STRUCTURE REHABILITATION — FORT HOOD

	ROOF	EXTERIOR SIDING	WOOD	CEMENT ASBESTOS	METAL/VINYL	WINDOWS	WOOD	ALUMINUM	OTHER	FLOORING	VINYL	CARPET	OTHER	WALL COVERING	GYPSUM DRYWALL	WALL BOARD/PANEL	CERAMIC TILE	PARTITIONS	CEILINGS	ACOUSTICAL TILE	OTHER	PLUMBING	WATER HEATERS	FIXTURES	HVAC UNIT	DUCTWORK	ELECTRICAL	WIRING	LIGHTING
TROOP BARRACKS																													
"BRUCKERIZATION"																													
"VOLARIZATION"																													
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ADMINISTRATION	●				●			●			●				●	●				●		●	●	●	●	●		●	●
WAREHOUSES	●				●																				●			●	●

Figure 8. Building rehabilitation at Fort Hood.

WW II TEMPORARY WOOD STRUCTURE REHABILITATION — FORT ORD

	ROOF	EXTERIOR SIDING	WOOD	CEMENT ASBESTOS	METAL/VINYL	WINDOWS	WOOD	ALUMINUM	OTHER	FLOORING	VINYL	CARPET	OTHER	WALL COVERING	GYPSUM DRYWALL	WALL BOARD/PANEL	CERAMIC TILE	PARTITIONS	CEILINGS	ACOUSTICAL TILE	OTHER	PLUMBING	WATER HEATERS	FIXTURES	HVAC UNIT	DUCTWORK	ELECTRICAL	WIRING	LIGHTING
TROOP BARRACKS																													
"BRUCKERIZATION"	●										●					●		●	●		●							●	●
"VOLARIZATION"	●										●					●		●	●		●							●	●
OTHER	●				●		●						●		●		●				●							●	●
DINING HALLS	●						●									●													
ADMINISTRATION	●				●				●		●	●			●	●				●				●	●	●		●	●
WAREHOUSES	●																											●	●

Figure 9. Building rehabilitation at Fort Ord.

WW II TEMPORARY WOOD STRUCTURE REHABILITATION — FORT MC COY

	ROOF	EXTERIOR SIDING	WOOD	CEMENT ASBESTOS	METAL/VINYL	WINDOWS	WOOD	ALUMINUM	VINYL	FLOORING	VINYL	CARPET	OTHER	WALL COVERING	GYPSUM DRYWALL	WALLBOARD/PANEL	CERAMIC TILE	PARTITIONS	CEILINGS	ACOUSTICAL TILE	OTHER	PLUMBING	WATER HEATERS	FIXTURES	HVAC UNIT	DUCTWORK	ELECTRICAL	WIRING	LIGHTING
TROOP BARRACKS																													
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OTHER	●			●			●		●		●		●		●	●		●		●		●	●	●	●	●		●	●
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Figure 10. Building rehabilitation at Fort McCoy.

Water resistant wallboard was used throughout, except in the showers where ceramic tile was installed and ventilation fans were added to remove the humid air. Renovated TWBs were retrofitted with new double-hung aluminum windows and resided with steel siding. New heating, ventilation, and air conditioning (HVAC) systems were added, including air conditioning in administration buildings. New ductwork and new plumbing lines were installed throughout.

Of the four installations investigated, Fort Ord has done the least to rehabilitate its existing WWII era buildings. These buildings are still used to house troops, although some of the barracks have been converted to administrative buildings. Several one-story buildings have been moved from their original sites and a youth center was created by connecting two WWII era TWBs.

Lighter structural framing seemed to be employed in the WWII wood buildings at Fort Ord. This is probably attributable to the mild climate (snow loads are not a factor) and local building practice. However, this practice has caused problems after building renovation when increased loading has been imposed upon the structural members due to furnishings (e.g., computer equipment in offices), increased occupancies, and partitioning which surpass design criteria.

The interior walls of troop barracks at Fort Ord were covered with gypsum drywall, new electrical wiring and lighting fixtures were installed, and new heating units and ductwork replaced the old HVAC system. The latrines were remodeled using water-resistant wallboard, ceramic tile, terrazzo tile flooring, and new plumbing fixtures. Exposed corroded sewer and water lines were replaced. Shower pans, neglected in the previous renovations, were added. The barracks interiors remain open with moveable partitions used as room dividers. All overhead ductwork was enclosed with gypsum drywall and new ceiling tiles and VAT flooring were installed.

Compared to the other installations, Fort McCoy is unique since approximately 93 percent of the buildings are still classified as temporary and have never undergone Bruckerization or Volarization. Projects have been undertaken on an as needed basis. Temporary renovations include adding room dividers or partitions (movable, free standing, or stud wall), electrical outlets, ceiling lights, floor and wall covering, and painting. This type of renovation is evident in some barracks that were temporarily used for special administrative purposes.

Permanent renovations were usually done in bachelor officer men's quarters (BOQs), bachelor enlisted men's quarters (BEQs), and administrative buildings. For the latter, renovation included partitioning the showers and latrines into men's and women's rooms, adding a new heating system, new ceiling and lighting fixtures, floor covering, baseboards, and a handicapped access ramp, and painting.

Renovations of troop barracks to BOQs and BEQs generally consisted of adding new permanent partitions, new plumbing (including new water and sewage lines and fixtures), electrical wiring, outlets and fixtures, and a new water heater and furnace. Exterior walls, the ground floor, and the attic were insulated, and new energy-efficient aluminum or vinyl-clad thermal windows were installed.

Existing Building Conditions

The following paragraphs summarize the findings at Forts Lewis, Hood, and Ord. Fort McCoy will be discussed separately, because, unlike the other three bases, it is not a

full-time military installation, and renovation and rehabilitation measures differed from those at the other study sites. Appendix C contains a complete tabulation of the survey results.

At Fort Ord, it was easiest to investigate the conditions of WWII era TWBs prior to renovation or rehabilitation. In over 90 percent of the buildings, the original wood siding was still intact. Successive exterior painting had color coded the buildings, making dating of progressive renewals relatively easy. The original wood double-hung windows were still in place. Damaged windows were routinely replaced with windows from other vacant WWII era TWBs.

In general, the WWII wood frame buildings at all the study sites were in good condition, considering their age and, in many instances, the relatively modest investment in their upkeep. As a result of the excellent quality of the wood construction and the overengineering of the buildings, most buildings were structurally sound. Very few TWBs were torn down because of serious structural deficiencies. The major reason for demolishing WWII era wood structures at the initial three study sites was because they were in the path of new construction.

Structural components that were considered in the inspections are foundation, exterior walls, roof, interior floors, and interior stairs. The most common type of foundation was spread footings/piles. Slab-on-grade foundations were also used. Some foundations were partly slab-on-grade and partly spread footing/piles. Nineteen foundations were judged average and four were judged good. Five foundations could not be seen. Settling of buildings did not appear to pose any problems.

Exterior walls were more likely to receive a poor rating. This can be attributed in part to the absence of eaves which left the siding vulnerable to water damage. This problem occurred at all three initial study sites. The walls of 2 of the 13 buildings inspected at Fort Lewis were in poor condition. Subsequent interviews with maintenance personnel also revealed that in some instances, entire walls had to be replaced as a result of water damage. In spite of this, 18 walls were in average condition and 6 were in good condition.

Other structural components were generally rated average to good. Although nine roofs (four at Fort Lewis and five at Fort Ord) were rated poor, this rating only reflects that the roof cover needed to be replaced. No sagging or other indications of structural problems were observed. Similar findings hold for interior floors and stairs.

Exterior sidings were usually either the original wood sidings (particularly at Fort Ord), or cement-asbestos shingles (particularly at Fort Lewis). Only at Fort Hood was new steel siding routinely installed on renovated buildings. Most sidings were in average condition.

Generally, the exterior finishes were rated average to good, although the exterior paint of five buildings was in poor condition. Four stairs/stoops were also in poor condition and some of the fire escape stairs were only marginally adequate.

Exterior windows were frequently in poor condition (Figure 11). In 14 buildings (half of the sample) windows were clearly inadequate. Exterior doors were in much better condition. In only four structures were they judged to be poor. In general they were rated average to good.

Figure 11. A window in poor condition.

Interior finishes were also often in poor condition. While the wood or the concrete floors of the TWBs were rated average to good, floor coverings were deficient in eight buildings. Similar results were obtained with respect to the wall coverings and partitions. Damaged partitions were observed frequently in Volarized barracks. In five buildings, the ceilings were poor, and in six buildings, the paint condition was below average. The paint condition was a particular problem at Fort Lewis. Maintenance personnel complained that preparation of the paint surface by outside contractors was not always satisfactory.

Given the age of the buildings, it is not uncommon to expect plumbing problems. Unfortunately, most of the plumbing is hidden away in floors and walls. It was, therefore, not possible to gain reliable information. In general, water and sewer lines that have not been replaced should be rated poor. Water heaters, fixtures, toilets, lavatories, and showers seemed to be in average to good condition.

The HVAC systems were in working order in all inspected buildings. Barracks usually did not have air conditioning and the furnaces were the original ones. While they seemed to be working fine, most units were rated average because of their age. Access to the utility room in some buildings was not possible. The ductwork was rated average to good in most cases. Overall, the HVAC system is probably adequate but does not deserve a good rating except were it has been completely replaced.

Finally, the electrical systems (lighting, wiring, switches, and service panels) were inspected. In general, the lighting and wiring had been updated over the years. The lighting was rated good in 18 of the 28 buildings, the wiring was judged good in 11 buildings, and switches and service panels were good in 8 buildings.

Generally, the TWBs at Fort McCoy were in good condition. One troop barracks was still in the original condition. No renovation had been undertaken and only minor signs of decay were detected.

Most foundations were spread footings. The footings were enclosed by perimeter wooden skirtings which were added after construction of the buildings. Minor dry rot problems were evident in some of the skirting.

The roofs, including the asphalt tiles and roof joists, were in good condition. Most of the roofing has been replaced and is routinely inspected for leaks and damage. The exterior walls of most buildings were covered with cement asbestos shingles and were in average condition.

Doors and windows were generally rated average to good. Most of the inspected buildings still had the original components. Minor damage such as peeling paint or broken glass is easily repaired and poses no problem.

The interior finishes differed substantially among the various building classifications. Renovated barracks had painted interior walls, while administration buildings, mess halls, and class rooms had vinyl wall covering. Movable partitions were widely used in offices. The interior finishes were in average to good condition.

Fort McCoy differs from the other three study sites in that most plumbing lines are exposed. Consequently, leaks are detected early and repairs are simple. In some of the renovated buildings, the plumbing lines have been enclosed within the walls. Water heaters, fixtures, toilets, lavatories, and showers were rated average to good.

The electrical systems in renovated buildings at Fort McCoy were rated good. The light fixtures in most of these buildings had been replaced and new conduits and wiring had been installed. Some troop barracks still had the original features. They were well maintained and safe and were rated average.

The HVAC systems were generally in good working condition. Heating systems vary considerably. The fuels used by the different systems are coal, oil, wood pellets, and gas. The latter was generally limited to "permanent" buildings.

Characteristics of Renovated Buildings

Renovations of WWII era wood frame buildings have been successful in the sense that they extended the useful life of the buildings and provided improved space or space for new uses. It is a tribute to the soundness of the materials and construction, as well as the flexibility permitted by the design, that these adaptions have yielded space that can be ranked average to good.

In spite of the positive impression of the renovated buildings, some obvious problems were noted. For barracks, the cost of renovation was usually kept in the range from $15 to $25/sq ft. This investment was not sufficient to upgrade all the major building services: plumbing, HVAC system, and electrical systems. Although the electrical

system was usually upgraded or replaced to meet modern standards, the plumbing and HVAC systems were only repaired as needed. This has lead to recurrent plumbing and HVAC problems which diminish the value of the improved space and create additional maintenance and operating costs.

The failure to completely replace the plumbing has resulted in problems with small leaks, requiring relatively frequent find-and-fix repairs. If leaks go undetected, which is likely where pipes are inaccessible (in walls or floor), continued exposure to moisture will damage the wood and may reduce the structural integrity of a building (see Figure 12).

Partitions were added during barracks renovations to create private space. This has resulted in a number of problems. First, the original duct system is not able to handle return air. This shortcoming has been dealt with by directing return air into the corridor through openings in the doors or walls. In case of a fire, this could cause smoke to accumulate in the corridor, barring the easiest escape route. Second, the original duct system does not perform satisfactorily in distributing heat to the rooms. Complaints about too much or too little heat were frequently voiced by building users. The repair records also show many calls because of the heating system. On several occasions, placing the thermostat on the wall to the boiler room added to the unsatisfactory performance of the heating system. The solution to these problems would be to either replace the original ductwork, or extend it so heat is properly distributed.

Most of the furnaces were original equipment. While they generated sufficient heat, modern equipment would be considerably more efficient. Also, the reliability of these units is likely to decrease with age. The furnaces should be replaced in a renovation aimed at bringing WWII era TWBs up to modern standards.

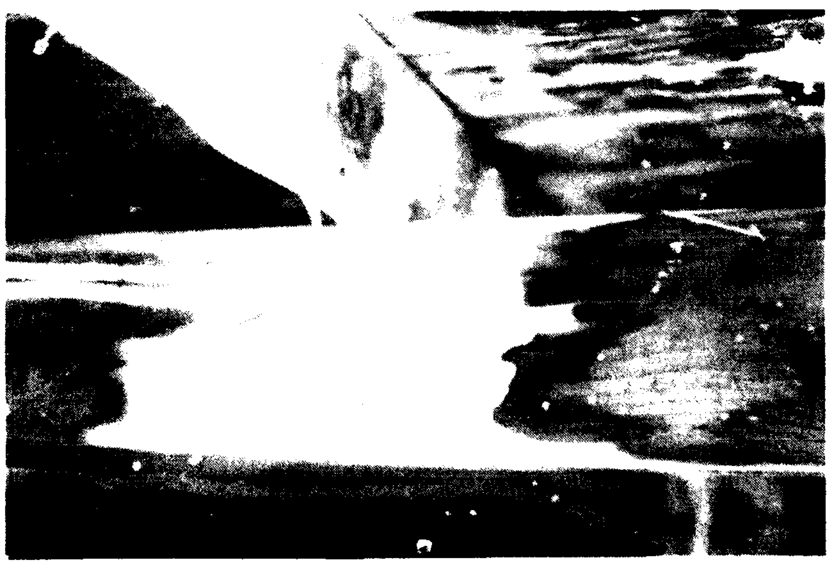


Figure 12. Signs of water damage to structural member of a two-story barracks.

A third observation concerns fire safety. In cases where the duct system was not replaced, smoke in the corridor may prevent users from safely reaching the fire escape at the end of the corridor. Also, the wooden ladder fire escapes are often in need of repair or replacement (Figure 13). In judging the fire safety of wood buildings in general, however, it should be noted that building contents are at least as important a source of fire hazard as the structure itself.[7]

Fourth, where two-story barracks are converted to offices for civilian employees, the question of access for the handicapped cannot be easily resolved. It might require adding an elevator to provide access to the second floor. For one story buildings, handicapped access can be easily provided by ramps.

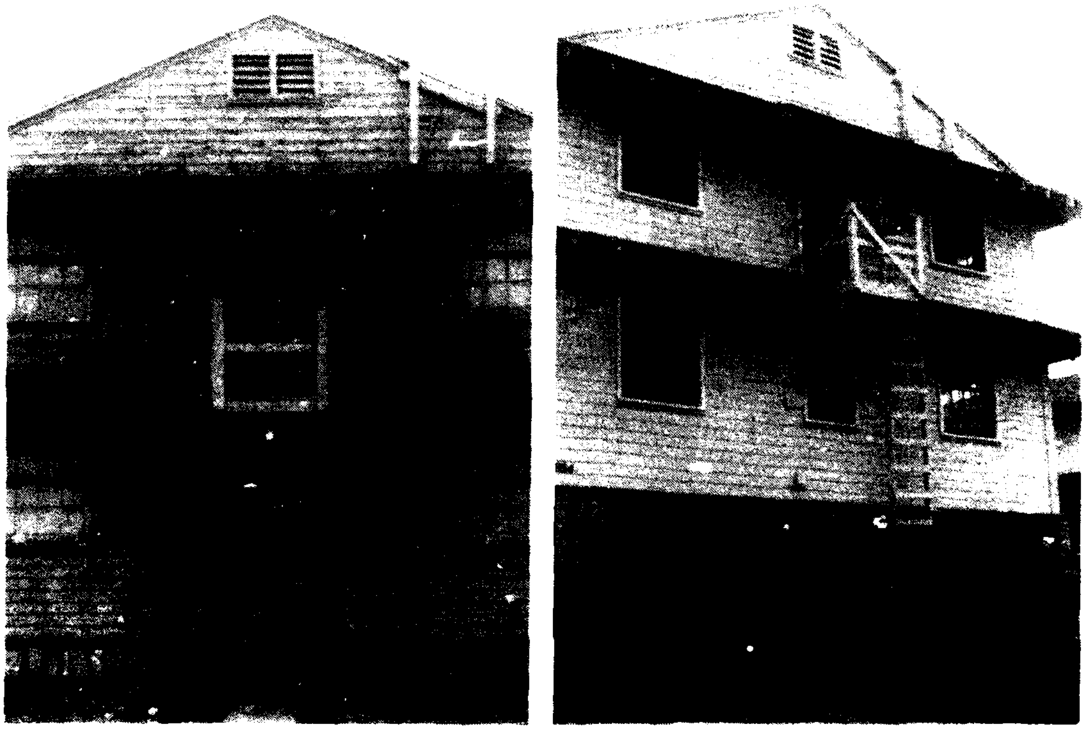


Figure 13. Fire escapes.

[7]C. A. Holmes, "The Fire Performance of Wood and Its Improvement by Fire-Retardant Treatments," *Proceedings of the American Wood Preservers' Association*, Vol 70 (1974).

4 COSTS OF RENOVATION

Average renovation and rehabilitation costs for barracks at Fort Lewis, Hood, and Ord, were \$15 to \$25/sq ft. Similar figures were mentioned for rehabilitation of administration buildings, although the range was greater. Some variations between installations, and even among buildings on the same installation, can be attributed to building-specific problems or to the extent of changes. At Fort McCoy, the average costs were slightly higher (\$25 to \$28), but some of the renovations were more extensive than at the other three study sites. Generally, costs were low compared to new construction. It is not possible, however, to directly compare the renovated buildings to new buildings. New construction will not be wood, and will not be the same size, floorplan, and components. A comparison, therefore, requires two steps. First, a qualitative assessment of the renovated buildings is necessary. Do they achieve the same standards as new buildings? Second, what is the operating cost (e.g., energy cost) of a renovated building, what is the maintenance cost to keep the building in good condition, and how do these costs compare to a new building containing state-of-the-art technology and materials?

The cost per square foot of most TWB renovations at all four study sites ranges from \$15 to \$28. This range applies to barracks and administration buildings containing 4,720 sq ft. One exception was found at Fort Lewis, where the most expensive troop barracks-to-administrative use conversion (euphemistically referred to as the Taj Mahal) was contracted for an estimated \$40/sq ft. In addition to replacing decayed, or damaged components, the following changes were made:

- interior partitions (2 by 4 wall studs, gypsum drywall, and wood panel wainscoting)
- wall-to-wall carpeting
- electrical wiring and fixtures
- suspended acoustical ceilings
- exterior wall insulation
- thermal pane double-hung aluminum windows
- coated metal siding
- fire escape stairs, smoke detectors, and sprinkler system.

In 1979, two TWB enlisted personnel mess halls at Fort McCoy were joined at a cost of about \$23,000 in current dollars. The additional work for renovation was done for another \$201,000 in current dollars. The renovated mess hall has an area of 5,483 square feet. The cost per square foot of this renovation (including some repairs in 1980) was between \$40 and \$45 (current dollars).

A very successful conversion/adaptive reuse of a WWII era warehouse was observed at Fort Hood. The 12,427-sq ft building, constructed in 1942, was built to withstand very heavy loads. This construction is ideal for conversion to office use because it virtually guarantees that the load capacity is sufficient for heavy furniture and substantial amounts of computer equipment. The conversion included additional services, moveable partitions, and new windows, doors, and steel siding. The cost of this conversion was less than \$13/sq ft. Table 3 provides a summary of the major costs for this rehabilitation.

Table 3

Cost of Converting a Warehouse to Administrative Use at Fort Hood, TX

Item	Labor Cost	Material Cost	Total Cost
Demolition	$11,309	$746	$12,055
Site Work	5,267	5,697	10,964
Concrete	2,210	1,052	3,262
Metals	6,469	7,134	13,603
Carpentry	19,413	19,728	39,141
Thermal and Moisture Protection	4,016	6,713	10,729
Doors and Windows	5,764	11,732	17,496
Finishes	15,781	26,117	41,898
Specialties	1,074	3,818	4,892
TOTAL	$71,703	$82,737	$154,040

Rehabilitation of an enlisted men's WWII era TWB barracks for administrative use was undertaken at Fort McCoy. The cost in current dollars was about $81,000 for this 5,455-sq ft building, or approximately $15/sq ft. Additions and changes are as follows:

- exterior wall, floor, and attic insulation
- interior partitions and walls (drywall with veneer coat plaster)
- suspended acoustical ceilings
- windows
- heating unit.

At Fort Lewis, temporary wood buildings were renovated at a cost of approximately $20/sq ft. It is possible to keep costs quite low as evidenced by the rehabilitation of 14 buildings at Fort Ord. A summary of the rehabilitation cost of those buildings is provided by Table 4. The very low cost ($3.10/sq ft) of rehabilitation at Fort Ord is remarkable. However, these rehabilitations did not replace either the plumbing or the HVAC system. Only faulty parts in these two systems were replaced. Doors and windows were replaced only as needed, and replacement windows were "cannibalized" from unused TWBs on the base. The buildings function satisfactorily, but do not achieve modern standards of comfort and privacy. Measured by the expenditure, however, the return on the investment is high.

Table 4

Rehabilitation of 14 Buildings at Fort Ord

Item	Total Cost
Demolition	$52,952
Carpentry	10,655
Doors and Windows	11,311
Shower and Latrines (Fixtures, Materials)	12,835
Mechanical	63,199
Electrical	5,685
Finishes	47,894
TOTAL	$204,531

Total Area: 66,080 sq ft
Cost per Square Foot: $3.10

5 OPERATION AND MAINTENANCE COSTS

Operating Costs

Operating costs consist of two major elements. One element is the expenditure for utilities: heating/air conditioning, water, and power. The water and power consumption should be the same for each use regardless of the type of building. Thus, in comparing modern construction to renovated WWII wood frame buildings, it can be assumed that expenditures on these two utilities are the same. Differences occur in the cost of heating and/or cooling. Certainly one would expect higher costs (per square foot) in WWII era buildings that have not been insulated and where the original furnace was not replaced. If the HVAC system has been replaced, the cost relative to building size should be about the same as for a newly constructed building.

The utility costs are dominated by the heating cost, followed by the cost of electricity.[8] Together they account for approximately 90 percent of the total utility costs. A survey at Fort McCo· found the typical heating cost (including hot water) for a 5,310 sq ft TWB barracks to be about $2,500 for FY85, based on an average occupancy rate of 78 percent. For an administration building of the same size, this cost was $3,500, and for a 1,800 sq ft classroom, the estimated cost was $2,000.

The second major element of operating costs is the efficiency of the building for a particular use. A new building can be designed to fit the needs of a particular use, but renovated buildings are less flexible in that some major characteristics of the building are already determined. This may result in less efficiency for a given use than if a new building were constructed. It is not possible to answer the question to what extent this could be a problem without reference to specific uses. However, the WWII era temporary wood buildings are very easily modified. Their open floor plan affords great flexibility in arranging the space to fit different uses. It is even possible to move buildings to another site, to join individual buildings together (as done at Fort Ord), or to extend an existing structure (as done at Fort Lewis). The buildings can be adapted to fit most requirements with minimal inconvenience and loss of efficiency for the users.

Maintenance Costs

One advantage of WWII temporary wood buildings is their simplicity. The components and systems are easily understood by maintenance personnel and are standardized, so parts are interchangeable. Buildings that have deteriorated beyond repair or are in the path of new construction can be "cannibalized" for parts. This simplicity and standardization makes them inexpensive to repair, as exemplified by the fact that deteriorated siding on a two-story barracks can be replaced at a cost of only $8,000 to $10,000.

These buildings are also easy to repair. Working with wood does not require any unique tools. Damaged wood walls are inexpensive to repair. Repairing damaged masonry or concrete is not only more expensive, but the repair may not be able to restore the original appearance. In wood buildings, it is relatively inexpensive to remove an inside wall cover to gain access to plumbing or wiring. This is often not the case with buildings constructed of other materials. Also, the building components have standard

[8] *Facilities Engineering and Housing: Annual Summary of Operations. Volume I - Executive Summary* (Department of the Army, 1984).

dimensions so emergency replacement parts can be found in local hardware stores. Some newer buildings do not have these advantages. For example, odd door or window dimensions have caused problems when components were damaged beyond repair. Not only did the replacements have to be specially ordered, but they were also more expensive than standard size components.

The renovations kept these buildings simple. The only instance where changes required new skills or tools is the installation of steel siding. When siding is damaged, special tools are necessary to make the repairs. Initially at least, these tools were not available at the study sites.

Relatively detailed information about maintenance and repair costs was available at Fort McCoy. For a sample of five BEQs and BOQs, the cost per square foot for FY85 was slightly below $1. These costs, however, include some interior painting. In other years, these costs would be expected to be lower.

The M&R cost for two mess halls was approximately $1.60/sq ft for FY85. This figure includes some major repairs of the kitchen facilities. For two classrooms (1,800 sq ft each), the cost was about $0.11/sq ft.

There are no indications that maintenance expenditures of wood frame buildings are inherently higher than those in structures made of other materials.

6 ECONOMIC FEASIBILITY OF RENOVATION

An accurate study of the economic feasibility of renovating TWBs depends on the intended use. A rough calculation of the economic feasibility of renovating a typical 4,720-sq ft WWII TWB barracks to be continued to be used as a barracks is given as an example. The cost of renovation will be compared to the cost of new construction. The FY86 cost estimate of $55 sq ft for a barracks without dining will be used.

To present this calculation, several assumptions are made. First, to arrive at a top dollar amount, assume that the WWII barracks are renovated more extensively than is presently the case. Since the range of renovation costs is $15 to $28, it is assumed that for $40/sq ft all services can be replaced or renewed to meet the same standards as those of a new building. Second, assume that after 10 years, $20,000 is needed to repair the renovated building, and that it then lasts another 10 years before additional resources would be needed. Also assume that a new building would need a major overhaul only after 20 years. Finally, assume that both new and renovated buildings have the same operating and maintenance costs. The interest rate for discounting purposes is set at 10 percent per annum.

These assumptions probably overstate the costs of the renovated WWII barracks. However, they are not entirely unrealistic. Under these assumptions, the present value of the cost of the renovated barracks (without maintenance and operating cost) is $198,000. This is lower than the $260,000 cost to construct 4,720 sq ft of new barracks space (at $55/sq ft). Under the assumptions listed previously, the cost of renovation is $62,000 less than the cost of new construction. From a different perspective, if a renovated barracks was more expensive to operate and maintain than a new barracks, over $7,000 more per year could be spent on the renovated barracks before the present value of its total cost would equal that of a new barracks. This simple example suggests that renovation of WWII could be an economical alternative to constructing new barracks. Similar conclusions also apply to other kinds of uses.

Realistic cost figures of renovations undertaken at the first three study sites are summarized in Table 5. The cumulative present value per square foot is quite low at just over $22 sq ft. Assuming that a new building would cost about $55/sq ft, and that there would be no major repairs during the first 20 years of that new building's life, the data indicate that any potential disadvantages of WWII era barracks would be compensated for by significantly lower costs. This suggests that WWII TWBs can be renovated economically.

To explore the example that is summarized in Table 5 further, assume that the building cost would be $55/sq ft and that major repairs would occur at the intervals and for the amount listed in the table. Under these assumptions, which favor the existing building, the cumulative net discounted cost of the new building would be $295,690, or less than $56/sq ft. This illustrates that the repairs have only a minor impact on the results of the analysis. The initial cost of renovation or of new construction, is the deciding factor.

In this example, the cost difference between new construction and renovation is large enough that significant changes in the assumptions would not alter the result. Renovation of troop barracks is likely to be economical even if the cost per square foot is increased to obtain a top dollar amount. The conversion of troop barracks to administrative uses also appears to be economical.

Table 5

Assumptions: Renovation of Typical WWII Era Barracks

Item	Initial Cost (Renovation Cost)	Frequency of Major Repairs	Cost of Major Repairs
Demolition	$9,100		
Carpentry	5,000	5 Years	#500.00
Floor Tile	6,500	5 Years	250.00
		10 Years	6,500.00
Dry Wall	10,100	5 Years	1,000.00
Windows	2,600	5 Years	250.00
Insulation	3,200		
Metal Doors	500	5 Years	250.00
		10 Years	500.00
Metal Siding	6,100	5 Years	250.00
Tile Work	2,700	5 Years	250.00
Painting	5,000	5 Years	5,000.00
HVAC	15,100	10 Years	1,000.00
Plumbing	15,000	10 Years	1,000.00
Electric	29,200	10 Years	1,000.00
Total Initial Cost	$110,100		

Other Assumptions: Building Size = 5310 square feet

Discount Rate = 10 per cent per annum

Life Time = 20 Years (until otherwise stated in Table 5)

Starting Year = 1987

Ending Year = 2006

Results: Cumulative Net Discounted Value = $117,689
Cumulative Net Discounted Value Per Square Foot = $22.16

Because there is insufficient hard evidence regarding renovating enlisted personnel dining facilities, it is desirable to study mess hall renovation in greater depth. Since the kitchens in the original mess halls are clearly too small, simple renovations may not result in solutions that are comparable to new construction. It may be necessary to join two mess halls together, as done at Fort McCoy, or to expand an existing mess hall, as done at Fort Lewis, to overcome this problem.

7 CONCLUSIONS

Economic Feasibility of Renovation

Renovation of WWII TWBs is a likely economical alternative to constructing new buildings. However, an accurate study of the economic feasibility of renovating TWBs depends on the intended use. Repair costs have only a minor impact on the outcome of economic analysis. The initial cost of renovation versus new construction is the deciding factor in determining the feasibility of renovation.

Physical Condition

Based on the physical condition surveys at Forts Lewis, Hood, and Ord, the WWII wood frame buildings were structurally sound and in good condition considering their age and the relatively modest investment in their upkeep. Exterior walls and windows are frequently in poor condition. Interior finishes are also in poor condition. Because of the age of the buildings, plumbing which had not been replaced was in poor condition. The electrical systems, which had been updated over the years, were in good condition and the HVAC systems were in working order.

The TWBs at Fort McCoy were in good condition. Most of the roofing had been replaced and the roof components were in good condition. The doors and windows were in average to good condition. Because the plumbing is exposed, leaks are detected and repaired early. The plumbing is in average to good condition. The electrical systems were rated good and the HVAC systems were in good working order.

Since most of the components in poor condition would have to be repaired or replaced in a complete renovation, they have little impact on the economic feasibility of renovation.

Cost Data

The experience of the four study sites suggests that structurally sound TWBs can be renovated at an average cost ($15 to $28/sq ft) that is competitive with that of new construction. This is particularly true if the objective is to provide temporary space, in which case the building standards can be lower than for permanent space. However, it must be noted that unless building services are also upgraded and/or replaced, the renovated structures cannot achieve modern standards of comfort and efficiency. Thus, while the investments yielded a good return in terms of improved space, a long-term solution would require additional resources.

WWII era wood frame buildings are as economical to maintain as new buildings made of different materials. This is particularly true for buildings that have been completely renovated, including upgrading or replacing building services to meet modern standards of reliability and efficiency.

The operating costs of a building that meets modern standards of insulation and energy efficiency are comparable to those of a new building.

Problems of Renovation and Use

The amount of money spent on renovation was usually insufficient to upgrade all the major building services. The buildings have recurrent plumbing and HVAC problems. The original duct system is not able to distribute heat satisfactorily or handle return air in partitioned barracks. Return air is often directed into the corridors. This could cause smoke to accumulate in the corridor and prevent users from safely reaching the fire escape ladders. Original heating systems are also much less energy efficient than modern equipment. If two-story barracks are converted to administrative use, access for the handicapped is impossible without additional renovation.

8 RECOMMENDATIONS

Because structurally sound WWII wood buildings can be considered well constructed "building frames" that can be turned into valuable permanent space for many uses, it is recommended that the Army study the best possible uses of these buildings from the perspective of ease and cost of conversion, convenience and operating efficiency, and maintenance costs.

It is also recommended that any investment in renovation be increased to an amount sufficient to either update or replace all building services so they will meet the same standards as those in new buildings. In most cases, this should be possible at a cost significantly below that of new construction.

It is also recommended that the Army prepare a sourcebook of conversion and renovation procedures and examples of successful conversions. This should include recommendations on materials and components and should discuss fire safety.

APPENDIX A:

BUILDING EVALUATION FORMS AND INSTRUCTIONS

The World War II Temporary Wood Structure Assessment Form (Figure A1) consists of two discrete parts: Building Components, comprising Building Data and Building Components Condition, and Building Life-Cycle Information. Building Components assesses the current condition of the existing structure and is intended to be used as a field inspection form. It is completed by the investigator for each unit surveyed. Building Life-Cycle Information is a synopsis of repairs, alterations, or replacements of the building components throughout the building's history. The investigator must have access to building records to complete this form.

Building Data and Components

Building Data includes all FORSCOM classification indexing pertaining to each building evaluated. Each building is assigned a FORSCOM classification number consisting of an initial prefix (designating the building use) followed by numerical digits (designating the specific building). The construction data for each building should also be recorded. Building size is the total building area recorded in square feet.

Each building surveyed will be classified according to building typology which includes the type of construction and the building use. The type of construction distinguishes among one-story and two-story buildings with wood, asbestos, or other siding and may have a slab-on-grade or spread/pile footing foundation. Check the appropriate box for each category.

Record the design use, intended use, and actual use of each building surveyed. This information is available through FORSCOM documentation. Discrepancies may arise among these categories.

A grid is provided for a scale drawing of the plan of each building surveyed. It is only necessary to draw the perimeter of the building with a straight-edge. Use solid lines to indicate existing construction and broken or dashed lines to indicate alterations, modifications, or additions. The overall building dimensions should be labeled in linear feet. Label any special conditions.

Record general comments or observations in the remarks section. Remarks may include information not recorded in other parts of the survey or qualifying remarks regarding building use, condition of the building or its components, maintenance of the building, or utilization of the building space.

The building components are grouped into generic categories (Figure A2). It is important to note that the building components are structurally interdependent and that a fundamental problem in one area of the building may have an effect on another area. Because it may be difficult to determine the exact relationships (even for an expert), the investigator should be aware of interrelated structural problems within each component category. The investigator should first walk around the exterior of the entire building to determine its general condition, but it is not until the investigator is inside the building that an accurate assessment can be made of a given building component.

WW II TEMPORARY STRUCTURES BUILDING COMPONENTS FILE CODE NUMBER

BUILDING DATA

BUILDING NUMBER
YEAR CONSTRUCTED
BUILDING SIZE
DESIGN USE
INTENDED USE
ACTUAL USE
TYPE OF CONSTRUCTION
☐ 1-STORY ☐ 2-STORY
FOUNDATIONS
☐ SPREAD FOOTINGS\PILES ☐ SLAB-ON-GRADE
EXTERIOR FINISH TYPE
☐ WOOD ☐ ASBESTOS ☐ METAL/VINYL
HANDICAPPED ACCESS ☐ YES ☐ NO
INSULATION ☐ FLOOR ☐ WALLS ☐ ROOF

REMARKS

BUILDING CONDITION

COMPONENTS	NOT APPLIC	POOR	AVERAGE	GOOD	NOT ACCESSIBLE
STRUCTURE					
FOUNDATION					
WALLS (EXTERIOR)					
ROOF					
FIRST FLOOR					
SECOND FLOOR					
STAIRS (INTERIOR)					
EXTERIOR SIDING					
WOOD					
ASBESTOS					
OTHER					
EXTERIOR FINISHES					
PAINTING					
STOOPS/STEPS					
RAMPS					
OTHER					
EXTERIOR WINDOWS/DOORS					
WINDOWS					
GLASS					
SASH					
FRAME					
EXTERIOR DOORS					
DOOR/FRAME					
HARDWARE					
INTERIOR FINISHES					
FLOORING					
WOOD					
TILE					
CONCRETE					
WALL COVERING					
PARTITIONS					
CEILINGS					
PAINTING					

INSPECTOR **DATE**

COMPONENTS	NOT APPLIC	POOR	AVERAGE	GOOD	NOT ACCESSIBLE
PLUMBING					
WATERLINES					
HOT					
COLD					
SEWERLINES					
WATERHEATERS					
FIXTURES					
TOILETS					
LAVATORIES					
SHOWER/BATHS					
HEATING/AIR CONDITIONING					
DUCTWORK					
HEATING UNIT					
AIR CONDITIONING UNIT					
OTHER					
ELECTRICAL					
LIGHTING					
WIRING					
SWITCHES					
SERVICE PANEL					
OTHER					
MISC.					

Figure A1. Temporary wood structure assessment form.

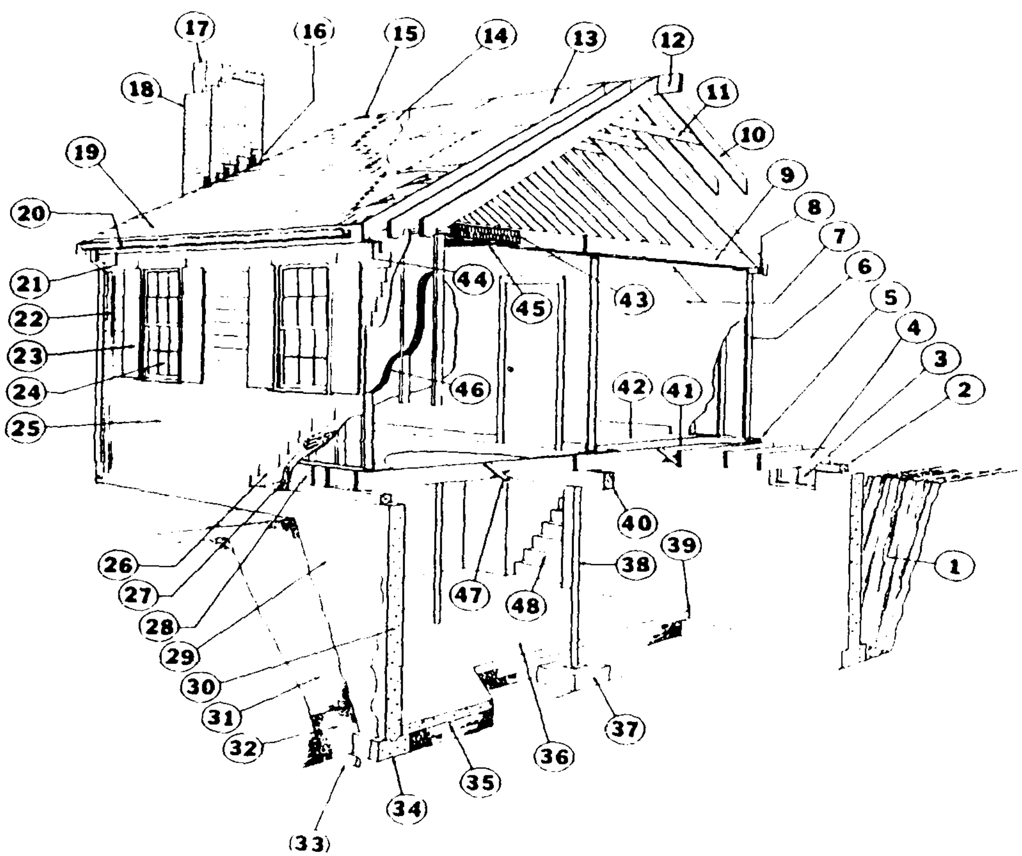
WW II TEMPORARY STRUCTURE LIFE-CYCLE INFORMATION FILE CODE NUMBER ____

DATE ____

1 The building is ________	☐ Used constantly	☐ Used seldom	☐ Vacant
2 If the building has been vacant for how long ?	☐ Greater than 5yrs	☐ Less than 5yrs	☐ Not Available
3 The building is maintained	☐ Regularly	☐ Irregularly	☐ Not at all
4 Modifications have been made to the origional building	☐ Yes	☐ No	☐ Not Available
5 If yes to (5), the modifications were	☐ Structural	☐ Nonstructural	☐ Not Available
6 Replacement, repairs, or alterations have been made to the following -			
☐ BUILDING STRUCTURE (foundations, walls, floors)	☐ Alteration	☐ Replacement	☐ Don't know
☐ ROOF (rafters, sheathing, shingles, vents, gutters)	☐ Alteration	☐ Replacement	☐ Don't know
☐ EXTERIOR DOORS (frames, hardware)	☐ Alteration	☐ Replacement	☐ Don't know
☐ EXTERIOR WINDOWS (frames, glass)	☐ Alteration	☐ Replacement	☐ Don't know
☐ EXTERIOR SIDING (wood, asbestos)	☐ Alteration	☐ Replacement	☐ Don't know
☐ EXTERIOR FINISHES (paint, steps)	☐ Alteration	☐ Replacement	☐ Don't know
☐ INTERIOR FINISHES (partitions, floor / wall coverings)	☐ Alteration	☐ Replacement	☐ Don't know
☐ PLUMBING (waterlines, waterheaters, fixtures)	☐ Alteration	☐ Replacement	☐ Don't know
☐ HEATING/AIR CONDITIONING (ducts, AC/Heating units)	☐ Alteration	☐ Replacement	☐ Don't know
☐ ELECTRICAL (lighting, wiring, service panels)	☐ Alteration	☐ Replacement	☐ Don't know
☐ MISCELLANEOUS (specify ________)	☐ Alteration	☐ Replacement	☐ Don't know
________)	☐ Alteration	☐ Replacement	☐ Don't know

Figure A1. (Cont'd)

Building Components



1 EXCAVATION
2 SILL PLATE
3 BASEMENT WINDOW
4 FLOOR JOIST
5 SHOE PLATE
6 STUDS
7 DRYWALL
8 PLATE
9 CEILING JOISTS
10 RAFTERS
11 COLLAR TIES
12 RIDGE RAFTER
13 ROOF SHEATHING
14 ROOF FELT
15 RIDGE SHINGLES
16 FLASHING
17 FLUE LINING
18 CHIMNEY
19 ROOF SHINGLES
20 GUTTER
21 FASCIA
22 DOWNSPOUT
23 SHUTTER
24 WINDOW
25 WALL SHINGLES
26 BUILDING PAPER
27 WALL SHEATHING
28 FIRE STOP
29 DAMPPROOFING
30 FOUNDATION WALL
31 BACKFILL
32 DRAINAGE STONE
33 DRAINAGE TILE
34 WALL FOOTING
35 GRAVEL
36 CONCRETE SLAB
37 COLUMN FOOTING
38 PIPE COLUMN
39 EXPANSION JOINT
40 GIRDER
41 SUB-FLOOR
42 FINISH FLOOR
43 ATTIC INSULATION
44 SOFFIT
45 CEILING STRAPPING
46 WALL INSULATION
47 CROSS BRIDGING
48 BULKHEAD STAIRS

Figure A2. Building components.

Roof

The roof is a weathertight enclosure which is primarily designed to shed water and protect the interior of the building and its inhabitants from the elements. The roof is typically constructed of parallel rows of wood rafters or a series of trusses which form the slopes or sides of the roof. The topmost point at which the rafters meet is called the ridge. The rafters are covered with wood sheathing (boards or plywood) forming a structural base for applying shingles or other waterproof material. The eaves are the projection of the roof beyond the wall and the underside is called a soffit. The fascia is a board enclosing the ends of the rafters.

Check the condition of the roof. The ridge should be straight (level) and the slopes or sides of the roof should appear to be level and uniform. If the roof has a perceptible sag, it may indicate structural problems in the roof itself or in the walls due to excessive or uneven building settling. (Evidence of excessive settling may also show up in the alignment of the walls, windows, and doors and as fractures in the foundation walls, piers, or concrete slab).

Check the condition of the shingles. The shingles should lie flat and be a uniform color (discoloration indicates wear). Shingles should not be broken or missing.

Water penetration (leaking) is of particular concern around roof projections such as vents and chimneys and at roof junctures (valleys). Typically, all joints are covered with a waterproof material (flashing) such as galvanized metal, bituminous material, or a waterproof membrane. Check to ensure that the flashing is intact and that no water penetration has occurred around these joints. Water penetration will be most detectable inside the building (most likely at the wall-to-ceiling junctures). Look for watermarks or staining on the walls or ceilings. (Water stains may not automatically indicate a leaky roof, but may be attributable to a broken or leaky water pipe or even due to condensation.)

All gutters and downspouts should be intact and free from corrosion and holes. The purpose of the gutters and downspouts is to carry water from the surface of the roof to the ground beyond the perimeter of the building. Gutters are installed at a slight slope, but will appear level and should not sag. Fascias and soffits should be intact and free from decay and insect damage.

Walls

Like the roof, the exterior walls protect the interior of the building and its inhabitants from the elements. Exterior walls are usually structural or loadbearing and transfer the weight of the building and its occupants to the ground via the foundation. In wood framed construction, the walls are constructed of vertical members (studs) covered with sheathing and siding on the exterior and gypsum drywall on the interior. Drywall is a composite of layered paper, felt, or fiberboard bonded to a hardened gypsum plaster core. Each drywall panel or sheet is nailed directly to the interior face of the stud wall and the joints are taped and finished with a gypsum compound. Drywall may be painted or covered with wallpaper. The space within the walls serves as a cavity for insulation, electrical wiring and plumbing. Interior nonstructural and nonloadbearing walls are called partitions.

The walls should appear vertical and should not buckle, bow, or show structural stress. Exterior siding should be intact and in good condition. If the siding is painted wood, the paint should not be cracked, blistered, or peeling. All wood components should

be free of any decay and insect damage. Wood members should feel solid to the touch (not "soft" or "spongy"), and should not crumble or pull apart easily.

Interior surfaces should be checked for evidence of moisture penetration. The condition of the paint or wallpaper should also be checked.

Windows/Doors

Windows allow light and air to enter the building. Windows are installed in units which include glass, sash surrounding the glass (this forms the operable part of the window), and the casings or frame which holds the entire window assembly together.

Doors allow egress into and out of the building. Life-safety typically requires two means of egress directly to the outside from each floor of the building. Like windows, doors are installed in units and include the door, the jamb (the vertical members against which the door closes), and the frame.

Windows and doors should be inspected from both the interior and exterior of the building. Windows and doors should be intact and function properly with minimal effort. Misalignment of windows and doors may indicate uneven or excessive settling of the building or, possibly, structural fatigue of the loadbearing members. However, discretion should be exercised since a certain amount of misalignment is acceptable in units of buildings this age. Windows and doors should fit snug within the frames for weathertightness to minimize air infiltration (drafts) and water penetration. When closed, windows should not rattle. All glass panes should be intact. Check the condition of all sashes and hardware.

It is probable that windows and doors have been replaced on some of the buildings surveyed. A special note may be appended to the remark section of the form if the building is scheduled to receive new components such as windows, doors, energy efficient lighting, new siding, or insulation.

Floors

Floor systems include structural members, such as wood joists and subflooring (usually plywood, partical board, or wood boards), and the finished floor (tile, carpet, wood). Floors must be able to structurally sustain a wide variety of loading conditions. Therefore, floor components will be designed to different specifications depending upon the building function and the loading conditions.

Wood floors should be level and feel solid underfoot. Perceptible "sagging" or "tilting" of the floor plane may indicate uneven building settling or, in extreme cases, structural fatigue or failure. A certain amount of settling is acceptable but excessive settling will result in structural damage. All finished floor materials should be intact and in relatively good condition.

Wood floor systems are typically raised above ground on foundation walls or on piles. Floor joists may be inspected (via crawl spaces) for decay, insect damage, or structural fatigue. A slab-on-grade concrete floor is a reinforced concrete slab poured directly on the ground. The slab should be level and free from structural stress (cracks). Typically, the slab is covered with a finished floor material such as carpet or, if exposed, painted. Minor cracks or fissures are normal and will not adversely affect the structural integrity of the slab.

Mechanical/Electrical

Mechanical and electrical systems are the support function of the building, promoting the safety and comfort of its inhabitants. The mechanical system includes the heating, ventilation, and air conditioning (HVAC) system as well as the plumbing system.

The heating and cooling requirements for each building will vary depending upon the climate and building use. Insulation may or may not have been added to the floors, walls, and roof to increase heating and cooling efficiency. Heating systems are generally divided into three main categories: forced air (requiring ducts), hot water (using pipes), and electric (using radiant coils). Most of the mechanical equipment is enclosed within the building structure and may not be accessible. Generally, it is only imperative to determine whether the system is functional.

Waterlines are typically small diameter pipes (1/2 to 2 in.) of copper, galvanized steel, or plastic (PVC) material. All valves and fixtures should should be intact and operable. Check for water leaks around valves and joints.

Sewerlines are large diameter pipes (4 to 6 in.) designed to carry waste water and sewerage from the building. Most of the sewerline will be below the ground and inaccessible. However, water should drain efficiently from all fixtures.

It is important to check the condition of the incoming electrical lines to the building. The electrical feeder may either be brought into the building overhead or below ground. If exposed, check the condition of the wiring for noticeable wear or fraying. Check the electrical service panel. The circuits will most likely have fuses or, if updated, breaker switches. In general, the electric system should be operable, light fixtures, switches, and outlets intact, and the electrical wiring should conform with National Electrical Council (NEC) specifications.

Life-Cycle

The life-cycle information is intended to be a summary of repairs, alterations or modifications, or replacements of the building's components throughout its history. This information will be completed by the investigator in conjunction with qualified military personnel.

For each question, mark the most appropriate response. If the component has been repaired, altered, or replaced, give the most recent date. Estimate the percentage of the building area used for the specific building function. For instance, if the building is administrative and the total building area is dedicated to this function, then the building's efficiency would be rated at 100 percent.

Assessment Form Summary

BUILDING DATA

1. Record building number (FORSCOM classification number)
2. Record year built
3. Record building size (area in Square Feet [SF] or perimeter in Linear Feet [LF] length x width)

4. Record building typology (check appropriate boxes)
5. Record building use (Intended Use, Design Use, and Actual Use)

BUILDING FLOOR PLAN DIAGRAM

1. Draw schematic floor plan of building to scale (building perimeter)
   a. Existing plan (solid lines)
   b. Original construction or modifications (dashed lines)

REMARKS

1. Note general comments or observations pertaining to overall condition of building components or building structure or building finishes
2. Note general comments or observations pertaining to changes in use and/or modifications to original building plan

BUILDING COMPONENTS

1. Record relative conditions of each building component (Figure A2)
   a. Not Applicable
   b. Floor Condition (requires major repair or replacement)
   c. Average Condition (requires minor repair or maintenance)
   d. Good Condition (requires no repair)
   e. Not Accessible

2. Cross reference listed components with Building Component Index (below) for location and description of component systems

Building Component Index

Foundation

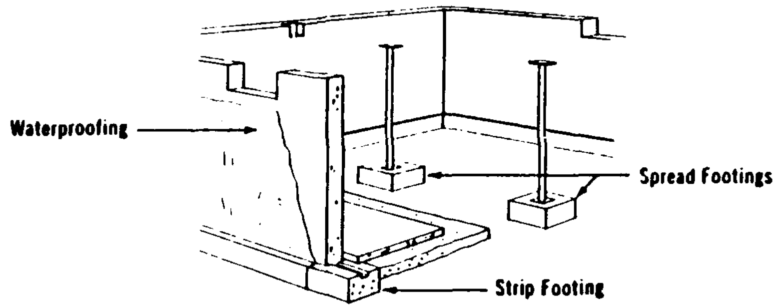
Indicate the type of foundation and assess its condition (Figure A3). Check for cracks or excessive settling in the foundation wall. Check the building/foundation connection at the top of the foundation wall for decay, insect damage, etc. Check for unusual movement (cracking or buckling) of the concrete floor slab-on-grade. Check the wood piles for decay or insect damage. Check concrete piles for cracking or unusual settling.

Note: Evidence of excessive settling may be detected in sagging roof, canted (non-vertical) walls, tilted floors, and misalignment of doors and windows. Severe settling may cause structural damage to the foundation, joists, studs, and rafters.

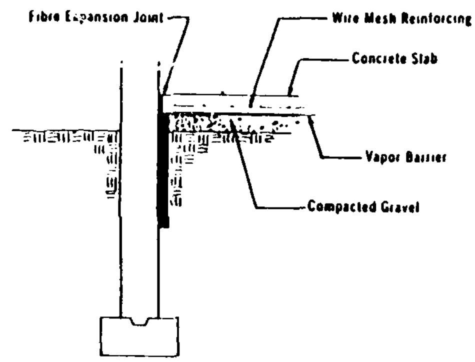
Walls

Check the condition of the walls (Figure A4). Walls should appear "plumb" or vertical. Indicate the exterior siding type (wood, asbestos, other) and condition. Check for decay or insect damage and that the siding is intact (no loose or missing pieces). Check the paint condition (blistering, peeling, checking, etc.) Check the condition of interior walls and partitions for cracks or damage and for the condition of the paint/wall covering.

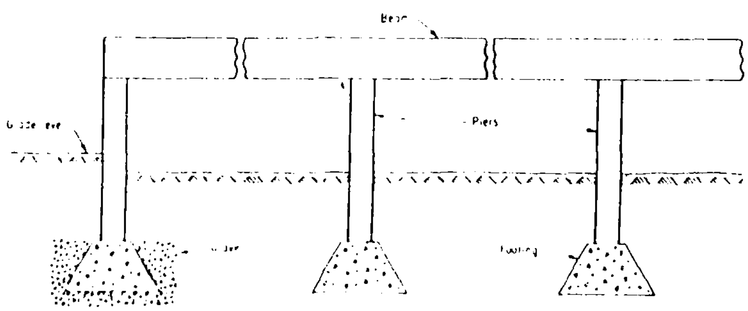
Note: Check all load-bearing walls and columns for signs of structural stress (cracking, buckling, or failure).



STRIP FOOTING



SLAB ON GRADE



PILE

Figure A3. Foundations.

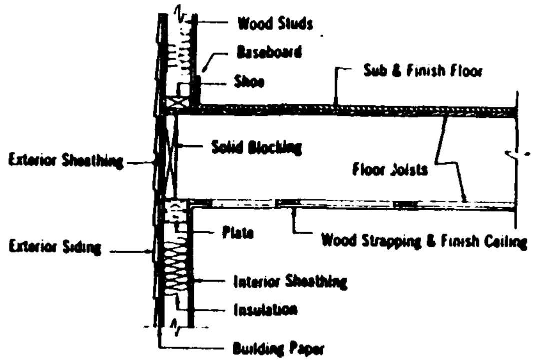
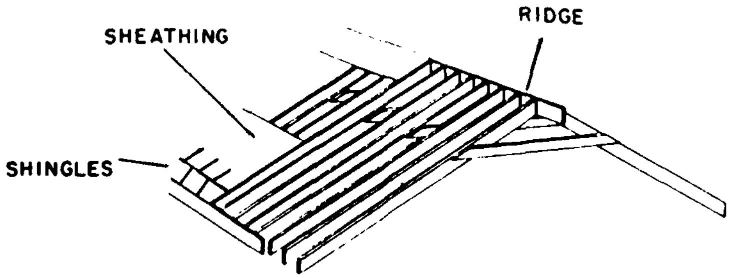


Figure A4. Wall structures.

Roof

Check the roof (Figure A5) for sagging at the ridge (top edge) and for the condition of shingles (uplifting, breaking, missing). Check for evidence of moisture penetration (leaking) and damage to interior walls and ceilings. Also check the rafters/trusses in the attic for decay or insect damage. Check the condition of flashing and roof vents (moisture penetration is a potential problem wherever a roof projection occurs). Check the condition of the fascia, gutters, and downspouts. Gutters should not sag and downspouts should be intact. Check for corrosion or holes on gutters and downspouts. Check the fascia for decay or insect damage.



Wood Rafters

Figure A5. Roof structures.

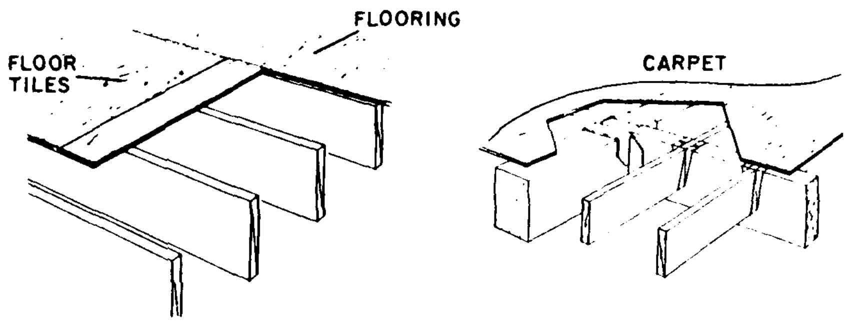
Floors

Check the condition of the floor (Figure A6). It should be level (should not sag). Check that the floor is solid underfoot. It should not bounce or seem "spongy." In the crawl space, check the floor joists for decay or insect damage and cracks. Joist should appear solid, not "punky." Check the floor/wall connection for decay or insect damage and check the finish of the floor coverings (carpet, tile, etc.).

Windows/Doors

Check the condition of window frames, sashes, and glass (Figure A7). Check for broken or missing panes, moisture penetration, decay, or insect damage. Check that the windows are intact and function properly. (Windows should fit snug in the frame).

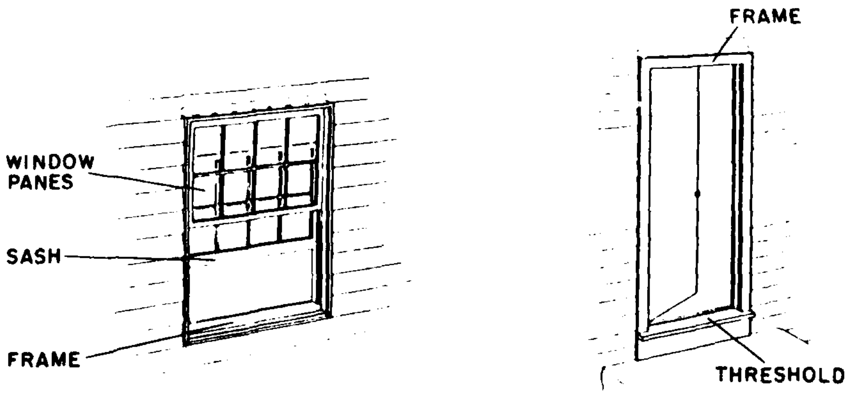
Check the condition of door frames, thresholds, and hardware (Figure A7). Check that the door is intact and functions properly. Check for decay, insect damage, moisture penetration, and paint condition.



Wood Joist

Wood Beam and Joist

Figure A6. Floor structures.



Exterior Door System

Figure A7. Window/door structures.

Mechanical Systems

Check for breaks or cracks in hot and cold water lines (Figure A8). Check the joints and connections for leaks. Check to see if the valves operate properly. Check the sewerline. Water should drain easily. Check the condition of waterheaters. They should be operational and show no corrosion on the outer jacket. Check the condition of fixtures (sinks, toilets). Check the condition of the ductwork, heating unit, and/or air handling unit. All systems should be operational.

Electrical System

Check the condition of the electrical wiring, lighting, and service panel (Figure A9). Check that the outlets and switches are operational. Also check the electric lines feeding to the service panel for signs of wear or breakage.

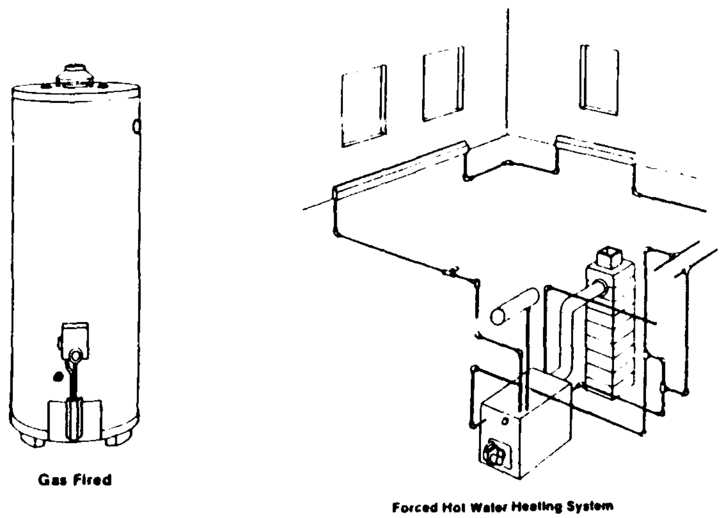


Figure A8. Mechanical systems.

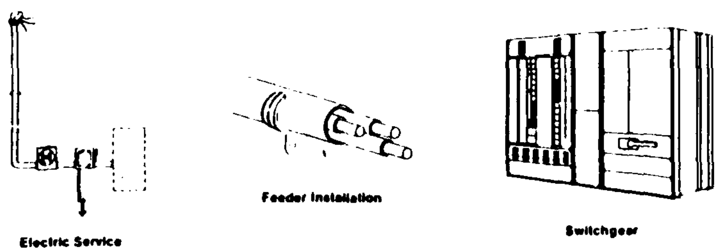


Figure A9. The electrical system.

APPENDIX B:

WEATHER DATA FOR STUDY SITES

Fort Lewis

Fort Lewis is situated in the Puget Sound-Lowlands region of the State of Washington (Figure B1). During spring and summer, the prevailing winds are from the west and northwest. This air is comparatively dry and cool. In winter the prevailing winds are from the west and southwest. This moist ocean air begins the wet season in October which peaks during the winter. It then decreases gradually. The average wind velocity per year is less than 10 miles per hour (mph).

Annual precipitation in this region ranges from 32 to 35 in. and winter snowfall ranges from 10 to 20 in. Precipitation increases with the slight elevation and distance from Puget Sound. Snow generally melts quickly and depth seldom exceeds 6 to 15 in.

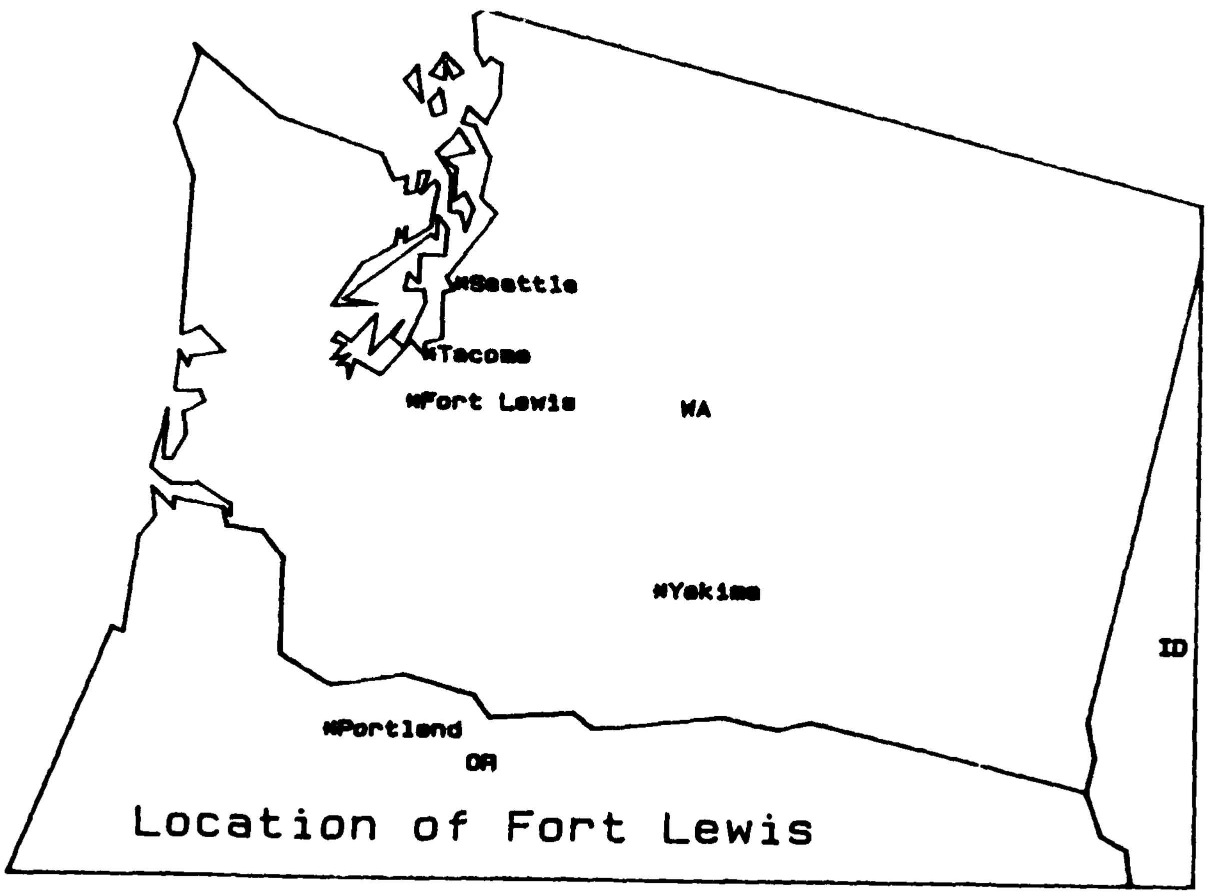


Figure B1. Location of Fort Lewis, WA.

The January maximum temperature ranges from 41 to 45 °F, and the minimum temperature ranges from 28 to 32 °F. Minimum temperatures from 0 to -10 °F have been recorded but temperatures seldom drop below 10 °F. During July, the temperature ranges from 73 °F near the Canadian border to 78 °F in the vicinity of Olympia. The minimum summer temperature is approximately 50 °F. Temperatures can reach 100 °F but during an average summer there are only three to five days with temperatures exceeding 90 °F.

In the Puget Sound region, and particularly in the Seattle-Tacoma vicinity, the average annual relative humidity is 85 percent in the early morning and 64 percent in the early evening.

Fort Hood

Fort Hood is located in the central region of Texas (Figure B2). The prevailing wind direction is from the south throughout the entire year. The average annual wind velocity is 11.7 mph, reaching a peak of 13.8 mph during March and April. Tornadoes have occurred in Texas during all seasons, but they are most frequent during April, May, and June.

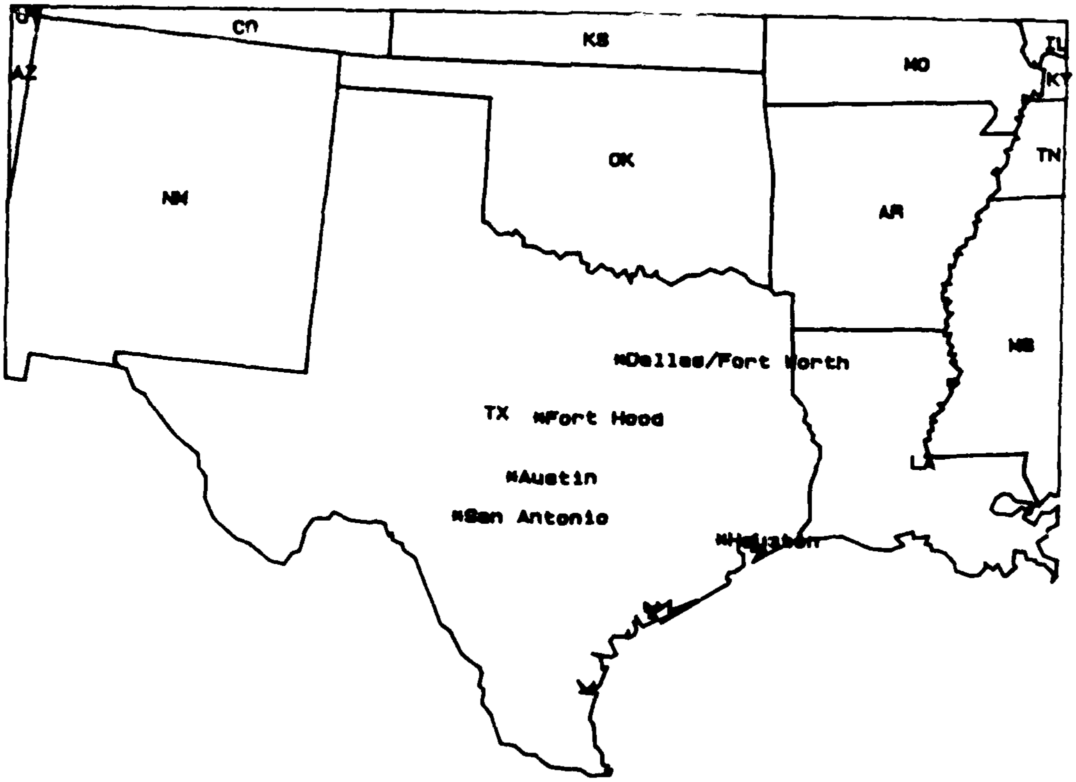


Figure B2. Location of Fort Hood, TX.

Average rainfall in the central region is between 32 and 36 in. Rains occur most frequently in late spring, peaking in May. July and August are relatively dry months. Snowfall rarely interferes with outdoor operations for more than an hour or two at a time. Snows of 4 in. or more are unusual.

The maximum temperature in winter for the central Texas region is 58 °F and the minimum temperature for January is 36 °F. The summer maximum temperature is 96 °F. The minimum temperature in July is 72 °F. The average annual temperature for central Texas is 66 to 68 °F.

The annual relative humidity in the central region is 82 percent in the early morning and 54 percent in the early evening.

Fort Ord

Fort Ord is situated on the Pacific coast of California, approximately 110 miles south of San Francisco, a few miles northeast of Monterey, along the western side of the Coast Range (Figure B3). The climate is dominated by the influence of the Pacific Ocean. Warm winters, cool summers, small daily and seasonal temperature ranges, and high relative humidities are characteristic for this area.

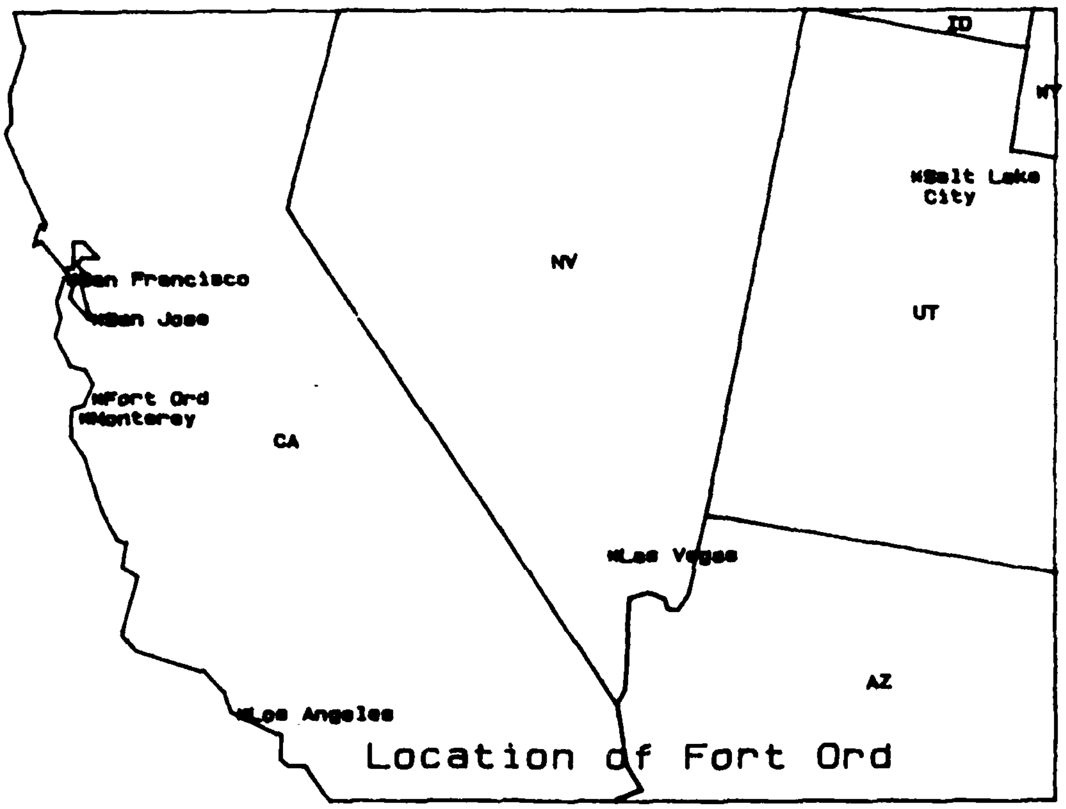


Figure B3. Location of Fort Ord, CA.

The prevailing wind direction is from the west and the northwest during most of the year averaging 10.5 mph. During winter, the wind direction and speed are modified by migratory pressure centers.

Total annual precipitation in the Monterey Bay area is about 20 in. per year. The months of heaviest precipitation are October to April. Snowfall is extremely rare.

Along the coastline, the variation in temperature is small, producing an unusually equable regime. In January, the minimum temperature is 36 °F and the maximum temperature is 60 °F. The respective figures for July are 52 °F and 72 °F.

In general, relative humidities are moderate to high along the coast throughout the year. The annual relative humidity in the early morning is 84 percent and is 61 percent in the early evening.

Fort McCoy

Fort McCoy is situated in West Central Wisconsin (Figure B4). The climate is typically continental with some modification due to the influence of Lakes Michigan and Superior. The prevailing winds blow from the south and the mean hourly wind speed is 9.5 mph.

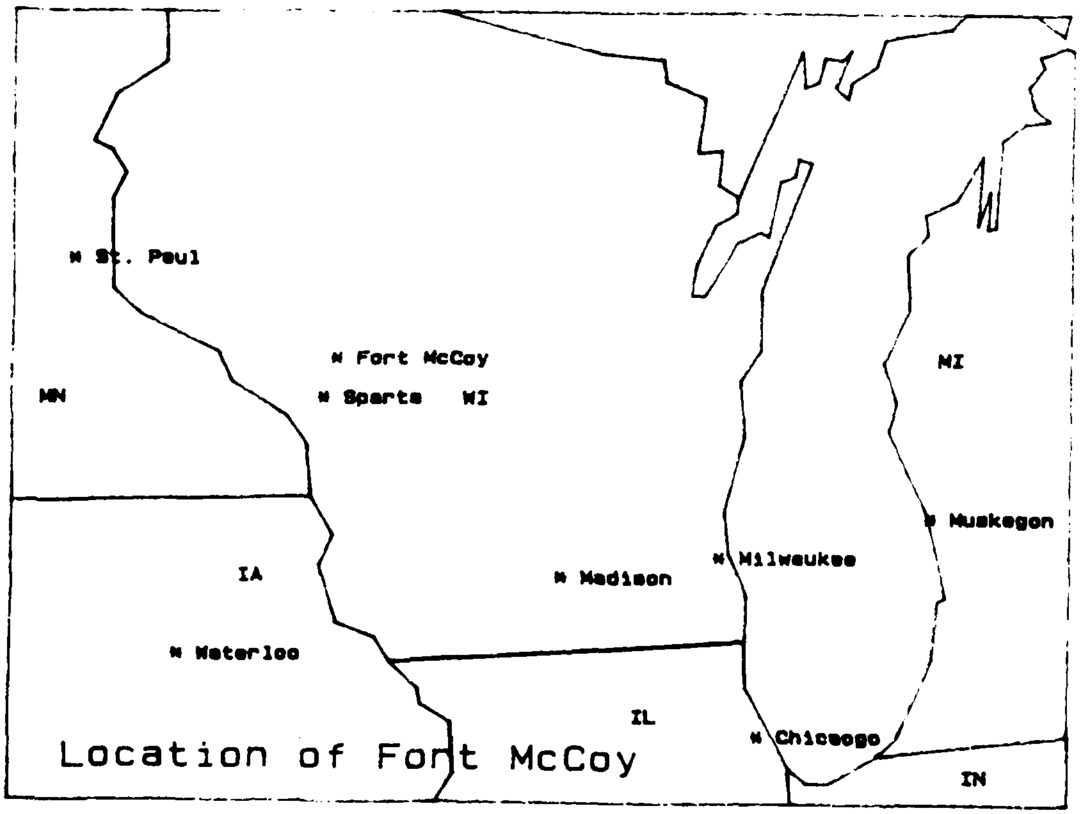


Figure B4. Location of Fort McCoy, WI.

The annual precipitation ranges from 30 to 34 in. over most of the region. The average seasonal snowfall varies significantly across the state, from about 30 in. near the southern border to over 100 in. in the north.

The maximum temperature is 103 °F in July. The minimum temperature is -37 °F in January.

The relative humidity is 81 percent in the early morning and 63 percent in the early evening.

About four tornadoes occur each year. Tornado frequency is highest in June and July, followed in order by April, May, and September.

APPENDIX C:

TABULATED BUILDING INSPECTION DATA

Table C1

Year Built

	Fort Lewis	Fort Hood	Fort Ord
1940	-	-	4
1941	9	-	4
1942	-	5	-
1943	1	-	1
1944	-	-	-
1945	2	-	-
unknown	1	-	1
Total	13	5	10

Table C2

Building Size

Sq ft	Fort Lewis	Sq ft	Fort Hood	Sq ft	Fort Ord
1144	2	3100	1	2206	1
2207	1	3241	1	2740	1
2323	1	5310	2	2892	1
4720	4	9000	1	4688	1
6136	1	-	-	4720	1
6220	1	-	-	8608	1
6809	1	-	-	unknown	1
7420	1	-	-	-	-
unknown	1	-	-	-	-
Total	13		5		10

Table C3

Usage

	Fort Lewis D*	Fort Lewis I	Fort Lewis A	Fort Hood D	Fort Hood I	Fort Hood A	Fort Ord D	Fort Ord I	Fort Ord A
general storage	-	1	-	2	2	1	2	2	2
administration	1	1	1	1	3	4	1	2	4
enlisted barracks	7	6	1	2	-	-	4	3	1
general instruction	-	1	6	-	-	-	-	-	-
detached day center	1	1	1	-	-	-	-	-	-
mess hall	3	2	3	-	-	-	2	2	2
unknown	1	1	1	-	-	-	1	1	1
Total	13	13	13	5	5	5	10	10	10

*D=Design, I=Intended (Recommended), A=Actual (Current) Usage.

Table C4

Type of Construction

	Fort Lewis	Fort Hood	Fort Ord
one-story	6	3	6
two-story	7	2	4
Total	13	5	10

Table C5

Foundation

	Fort Lewis	Fort Hood	Fort Ord
spread footings/piles	10	5	7
slab-on-grade	2	-	2
both	1	-	1
Total	13	5	10

Table C6

Exterior Finish

	Fort Lewis	Fort Hood	Fort Ord
wood	-	2	9
asbestos	11	-	-
metal/vinyl	2	3	1
Total	13	5	10

Table C7

Handicapped Access

	Fort Lewis	Fort Hood	Fort Ord
not answered	1	2	4
yes	-	1	1
no	12	2	5
Total	13	5	10

Table C8

Insulation

	Fort Lewis	Fort Hood	Fort Ord
not answered	6	3	8
floor	-	-	-
walls	-	-	-
roof	-	-	
walls and roof	1	1	2
none	6	1	-
Total	13	5	10

Table C9

Capacity

	Fort Lewis	Fort Hood	Fort Ord
0	1	2	2
19	-	1	-
23	-	-	1
24	1	-	-
25	2	-	-
27	-	-	1
28	1	-	-
30	2	-	-
36	2	-	3
50	-	2	-
140	3	-	-
200	-	-	1
250	-	-	1
unknown	1	-	1
Total	13	5	10

Table C10

Structure

Component/Fort	Not app*	Poor	Aver	Good	Not acc	Not ans	Total
Foundation							
Lewis	-	-	11	1	1	-	13
Hood	-	-	2	1	-	2	5
Ord	-	-	6	2	-	2	10
Walls (exterior)							
Lewis	-	2	9	2	-	-	13
Hood	-	-	2	3	-	-	5
Ord	-	-	7	1	-	2	10
Roof							
Lewis	-	4	8	1	-	-	13
Hood	-	-	2	3	-	-	5
Ord	-	5	3	1	-	1	10
First Floor							
Lewis	-	-	9	3	-	1	13
Hood	-	2	-	3	-	-	5
Ord	-	1	8	-	-	1	10
Second Floor							
Lewis	5	-	4	2	-	2	13
Hood	3	-	2	-	-	-	5
Ord	5	-	3	-	-	2	10
Stairs (interior)							
Lewis	5	-	6	-	-	2	13
Hood	3	2	-	-	-	-	5
Ord	4	1	3	-	-	2	10

*Not app=not applicable, Aver=average, Not acc=not accessible, Not ans=not answered.

Table C11

Exterior Siding

Component/Fort	Not app*	Poor	Aver	Good	Not acc	Not ans	Total
Wood							
Lewis	1	-	-	1	-	11	13
Hood	-	-	2	-	-	3	5
Ord	1	1	5	-	-	3	10
Asbestos							
Lewis	-	2	8	1	-	2	13
Hood	2	-	-	-	-	3	5
Ord	6	-	-	-	-	4	10
Painting							
Lewis	-	1	9	2	-	1	13
Hood	2	2	-	-	-	1	5
Ord	-	2	1	4	-	3	10
Steps/Stoops							
Lewis	-	2	9	1	-	1	13
Hood	-	2	-	2	-	1	5
Ord	1	-	6	-	-	3	10
Ramps							
Lewis	3	2	6	-	-	2	13
Hood	3	-	-	1	-	1	5
Ord	7	-	-	-	-	3	10

*Not app=not applicable, Aver=average, Not acc=not accessible, Not ans=not answered.

Table C12

Exterior Walls/Doors

Component/Fort	Not app*	Poor	Aver	Good	Not acc	Not ans	Total
Windows							
Lewis	-	8	2	3	-	-	13
Hood	-	2	-	2	-	1	5
Ord	-	4	6	-	-	-	10
Glass							
Lewis	-	4	5	4	-	-	13
Hood	-	1	1	2	-	1	5
Ord	-	-	9	1	-	-	10
Sash							
Lewis	-	4	6	3	-	-	13
Hood	-	2	-	2	-	1	5
Ord	-	4	6	-	-	-	10
Frame							
Lewis	-	6	4	3	-	-	13
Hood	-	2	-	2	-	1	5
Ord	-	2	7	-	-	1	10
Storm Screen							
Lewis	9	-	3	1	-	-	13
Hood	-	-	-	-	-	5	5
Ord	8	-	-	-	-	2	10
Exterior Doors							
Lewis	-	3	9	-	-	1	13
Hood	-	-	-	-	-	5	5
Ord	-	1	5	2	-	2	10
Door Frame							
Lewis	3	8	1	-	-	1	13
Hood	-	2	2	-	-	1	5
Ord	-	1	4	2	-	3	10
Hardware							
Lewis	2	-	4	7	-	-	13
Hood	-	2	-	2	-	1	5
Ord	-	1	4	2	-	3	10

*Not app=not applicable, Aver=average, Not acc=not accessible, Not ans=not answered.

Table C13

Interior Finish

Component/Fort	Not app*	Poor	Aver	Good	Not acc	Not ans	Total
Flooring/Wood							
Lewis	-	-	5	4	-	4	13
Hood	-	-	3	2	-	-	5
Ord	1	1	7	-	-	1	10
Flooring/Concrete							
Lewis	2	-	2	2	-	7	13
Hood	-	-	1	1	-	3	5
Ord	4	-	1	-	-	5	10
Floor Covering							
Lewis	-	5	3	5	-	-	13
Hood	-	2	3	-	-	-	5
Ord	1	1	2	4	-	2	10
Wall Covering							
Lewis	-	4	5	3	-	1	13
Hood	-	2	-	3	-	-	5
Ord	1	1	3	3	-	2	10
Partitions							
Lewis	-	8	3	2	-	-	13
Hood	-	-	-	3	-	2	5
Ord	-	-	6	3	-	1	10
Ceilings							
Lewis	-	5	3	4	-	1	13
Hood	-	-	1	2	-	2	5
Ord	1	-	3	5	-	1	10
Painting							
Lewis	-	5	5	3	-	-	13
Hood	2	-	-	-	-	3	5
Ord	1	1	3	4	-	1	10

*Not app=not applicable, Aver=average, Not acc=not accessible, Not ans=not answered.

Table C14

Plumbing

Component/Fort	Not app*	Poor	Aver	Good	Not acc	Not ans	Total
Water Lines							
Lewis	2	-	2	3	-	6	13
Hood	-	-	-	1	3	1	5
Ord	-	1	6	-	-	3	10
Hot Water							
Lewis	1	1	6	3	-	2	13
Hood	-	-	-	2	1	2	5
Ord	-	2	5	-	1	2	10
Cold Water							
Lewis	1	1	6	3	-	2	13
Hood	-	-	-	2	1	2	5
Ord	-	2	5	-	1	2	10
Sewer Lines							
Lewis	2	1	4	2	1	3	13
Hood	2	-	-	1	2	-	5
Ord	-	3	1	-	5	1	10
Water Heaters							
Lewis	2	1	3	-	2	5	13
Hood	-	-	-	-	1	4	5
Ord	1	1	2	2	1	3	10
Fixtures							
Lewis	3	1	2	3	-	4	13
Hood	2	-	-	2	-	1	5
Ord	2	-	4	2	-	2	10
Toilets							
Lewis	4	1	5	1	-	2	13
Hood	2	-	-	2	-	1	5
Ord	2	-	5	3	-	-	10
Lavoratories							
Lewis	4	1	5	1	-	2	13
Hood	2	-	-	2	-	1	5
Ord	2	1	4	-	-	3	10
Shower/Baths							
Lewis	4	1	4	2	-	2	13
Hood	4	-	-	-	-	1	5
Ord	7	-	1	1	-	1	10

*Not app=not applicable, Aver=average, Not acc=not accessible, Not ans=not answered.

Table C15

Heating/Air Conditioning

Component/Fort	Not app*	Poor	Aver	Good	Not acc	Not ans	Total
Ductwork							
Lewis	-	1	6	1	3	2	13
Hood	-	2	-	2	-	1	5
Ord	5	-	3	-	1	1	10
Heating Unit							
Lewis	-	-	3	1	3	6	13
Hood	-	-	-	2	-	3	5
Ord	-	-	7	1	-	2	10
Air Conditioning Unit							
Lewis	7	-	-	-	-	6	13
Hood	2	-	-	2	-	1	5
Ord	9	-	-	-	-	1	10

*Not app=not applicable, Aver=average, Not acc=not accessible, Not ans=not answered.

Table C16

Electrical Components

Component/Fort	Not app*	Poor	Aver	Good	Not acc	Not ans	Total
Lighting							
Lewis	-	2	3	6	-	2	13
Hood	-	2	-	3	-	-	5
Ord	-	-	3	7	-	-	10
Wiring							
Lewis	-	1	6	4	-	2	13
Hood	-	2	-	2	-	1	5
Ord	-	-	3	5	2	-	10
Switches							
Lewis	-	2	6	1	-	4	13
Hood	-	2	-	2	-	1	5
Ord	-	-	5	5	-	-	10
Service Panel							
Lewis	-	1	2	1	-	9	13
Hood	-	2	-	2	-	1	5
Ord	-	-	3	5	-	2	10

*Not app=not applicable, Aver=average, Not acc=not accessible, Not ans=not answered.

Table C17

Miscellaneous Components

Component/Fort	Not app*	Poor	Aver	Good	Not acc	Not ans	Total
Fire Alarms							
Lewis	2	1	5	2	1	1	13
Hood	4	-	-	-	-	1	5
Ord	3	-	-	5	-	2	10
Fire Escape							
Lewis	4	5	1	-	-	3	13
Hood	2	-	2	-	-	1	5
Ord	5	2	1	2	-	-	10

*Not app=not applicable, Aver=average, Not acc=not accessible, Not ans=not answered.

GLOSSARY

STRUCTURE

Footing: An enlargement at the lower end of a foundation wall, pier, or column designed to distribute the load.

Foundation: The substructure or base supporting a building.

Pier: A vertical structural support.

Pile: A long slender column of timber, steel, or reinforced concrete driven into the ground to carry a load.

Sill Plate: A horizontal piece that forms the lowest member or one of the lowest members of a framework or supporting structure.

WALL

Drywall: A board used in large sheets in walls and consisting of several plies of fiberboard, paper, or felt bonded to a hardened gypsum plaster core.

Partition: An interior dividing wall (usually nonstructural or nonloadbearing).

Sheathing: The first covering of boards or of waterproof material on the outside wall of a frame building.

Stud: One of the uprights in the framing of the walls of a building to which sheathing, paneling, or laths are fastened.

ROOF

Collar Tie: The horizontal member of a roof connecting opposite rafters (located between the ridge beam and the ceiling joists).

Eaves: The lower border of the roof that overhangs the wall.

Fascia: A board enclosing the ends of the rafters.

Flashing: Sheet metal, bituminus material, or other waterproof material to protect against rain.

Rafter: Anv of the parallel beams that support a roof.

Ridge: The line of intersection at the top between the opposite slopes or sides of a roof.

Soffit: The underside of a part or member of a building (as of an overhang or staircase).

Truss: A rigid framework forming the structural members of a roof.

FLOOR

Bridging: Small crossed wood or metal members between floor joists.

Joist: Any of the small timbers or metal beams ranged parallel from wall to wall in a structure to support the floor.

Slab: A flat rectilinear architectural element that is usually formed of a single piece or mass (concrete floor).

Subfloor: A layer of boards or plywood laid horizontally over floor joists to support the finished floor.

WINDOW/DOOR

Frame: The open case or structure made for enclosing or supporting a window or door.

Jamb: An upright piece or surface forming the side of an opening (window, door).

Sash: The framework in which panes of glass are set in a window or door (usually forms the moveable part of a window).

Threshold: The plank, stone, or piece of timber that lies under a door.

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